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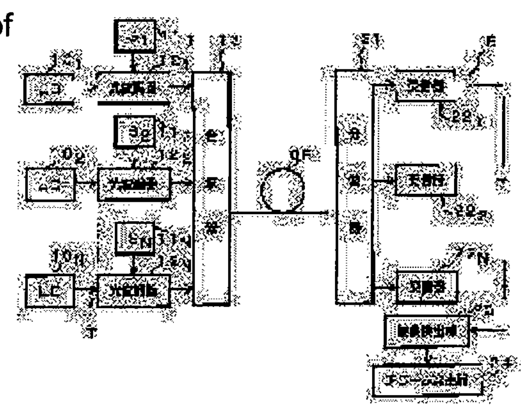
(54) WAVELENGTH MULTIPLEX LIGHT TRANSMISSION DEVICE AND OPTICAL REPEATER

(57)Abstract:

PURPOSE: To issue an abnormality warning when wavelength deviation between a transmission wavelength and a wavelength giving the minimum loss of a branching filter becomes more than an allowance value and to previously prevent the deterioration of reception sensitivity owing to wavelength deviation.



CONSTITUTION: The branching filter 21 branching wavelength multiplex signal light transmitted through an optical fiber for the respective wavelengths, receivers 221-22N receiving the output light of the branching filter 21 and a wavelength detection part 23 detecting wavelength deviation between the wavelength giving the minimum loss of the branching filter 21 and the transmission wavelength are provided. An alarm

generator 24 judging abnormality when wavelength deviation detected by the wavelength detection part 23 becomes more than the allowable value and issues the alarm is provided.

CLAIMS

[Claim(s)]
[Claim 1]Wavelength multiplexing transmission equipment comprising:
A spectral separation means to separate spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength.
A receiver which receives an outputted ray of this spectral separation means.
A wavelength detecting means which detects a wavelength gap with wavelength and a transmission wave length which do the minimum loss of said spectral separation means.
A means to judge abnormalities when a wavelength gap detected by this wavelength detecting means becomes beyond an acceptable value, and to report.

[Claim 2]The wavelength multiplexing transmission equipment according to claim 1, wherein said wavelength detecting means detects a wavelength gap from change of a receiving level of an outputted ray of said spectral separation means.
[Claim 3]Said spectral separation means has a control means which controls the transmitted wave length characteristic, and said wavelength detecting means has a means to send out a control signal to said control means, The wavelength multiplexing transmission equipment according to claim 1 or 2 detecting a wavelength gap by changing the characteristic of said spectral separation means by said control means according to said control signal.
[Claim 4]Two or more semiconductor lasers which have a different oscillation wavelength, and a laser control means which controls an operating state of said semiconductor laser are established, and said wavelength detecting means, Wavelength multiplexing transmission equipment given in the any 1 according to claim 1 to 3 having a means to transmit a control signal to said laser control means, and detecting a wavelength gap from change of an operating state of said semiconductor laser based on an input signal of said receiver.
[Claim 5]Wavelength multiplexing transmission equipment given in any 1 [characterized by

comprising the following] of claims 1 thru/or 4.
An amplifying means which amplifies a wavelength multiplexing signal light transmitted via an optical fiber, and inputs an amplified wavelength multiplexing signal light into said spectral separation means.
A gain control means to control a gain of said amplifying means based on an optical signal level of a wavelength multiplexing signal light inputted into said spectral separation means.

[Claim 6]Wavelength multiplexing transmission equipment comprising:
Several semiconductor lasers in which oscillation wavelengths differ.
The 1st monitor means that supervises an operating state of this semiconductor laser.
A wavelength standard machine used as a standard of a transmission wave length.
The 2nd monitor means that supervises an oscillation wavelength of said semiconductor laser based on this wavelength standard machine, and a means to judge to be unusual when an oscillation wavelength of said semiconductor laser produces a gap rather than said wavelength standard machine based on surveillance intelligence from the 1st and 2nd monitor means beyond an acceptable value, and to report.

[Claim 7]The wavelength multiplexing transmission equipment according to claim 6, wherein said wavelength standard machine is an optical multiplexing machine.
[Claim 8]Wavelength multiplexing transmission equipment comprising:
Several semiconductor lasers with which oscillation wavelengths differ.
The 1st monitor means that supervises an operating state of the semiconductor laser.
A multiplexing means to multiplex an outputted ray of said semiconductor laser and to obtain a wavelength multiplexing signal light.
A spectral separation means to separate spectrally said wavelength multiplexing signal light transmitted via an optical fiber for every wavelength, A receiver which receives an outputted ray of this spectral separation means, and a wavelength detecting means which detects a gap with wavelength and a transmission wave length which do the minimum loss of said spectral separation means, The 1st decision means judged to be unusual when said wavelength gap becomes beyond an acceptable value, and a means to specify any are more unusual between the transmitting side or a receiver based on an output signal from said surveillance intelligence from the 1st monitor means, and said wavelength detecting means when it is judged that this 1st decision means is unusual.

[Claim 9]The wavelength multiplexing transmission equipment comprising according to claim 8:
A wavelength standard machine used as a standard of a transmission wave length.
The 2nd monitor means that supervises an oscillation wavelength of said semiconductor laser

based on this wavelength standard machine.
The 2nd decision means judged to be unusual when an oscillation wavelength of said semiconductor laser produces a gap rather than said wavelength standard machine based on surveillance intelligence from said 1st monitor means and the 2nd monitor means beyond an acceptable value.
A means to specify any are more unusual between the transmitting side or a receiver based on an output signal of surveillance intelligence from said 1st and 2nd monitor means, and said wavelength detecting means when it is judged that said 1st decision means is unusual.

[Claim 10]The wavelength multiplexing transmission equipment according to claim 9, wherein said wavelength standard machine is an optical multiplexing machine.
[Claim 11]Wavelength multiplexing transmission equipment given in any 1 [characterized by comprising the following] of claims 8 thru/or 10.
Two or more semiconductor lasers which have a different oscillation wavelength.
A multiplexing means to multiplex an outputted ray from this semiconductor laser, and to obtain a wavelength multiplexing signal light.
A wavelength detecting means which detects an oscillation wavelength of said semiconductor laser from an outputted ray of this multiplexing means.
A control means which controls wavelength of said semiconductor laser on wavelength which does the minimum loss of said multiplexing means based on an output of this wavelength detecting means.

[Claim 12]Wavelength multiplexing transmission equipment comprising:
Two or more semiconductor lasers which have a different oscillation wavelength.
A multiplexing means to multiplex an outputted ray from this semiconductor laser, and to obtain a wavelength multiplexing signal light.
A spectral separation means to separate spectrally said wavelength multiplexing signal light transmitted via an optical fiber for every wavelength.
A receiver which receives an outputted ray of this spectral separation means, a means to detect a signal to noise ratio in this receiver, and a control means which controls a transmission wave length so that a detected signal to noise ratio serves as the maximum.

[Claim 13]Two or more semiconductor lasers which have different wavelength, and a semiconductor laser of a reserve which has different wavelength from these semiconductor lasers, A multiplexing means to multiplex an outputted ray of said semiconductor laser and to obtain a wavelength multiplexing signal light, An optical fiber which transmits this wavelength multiplexing signal light, and a spectral separation means to separate said wavelength

multiplexing signal light spectrally for every wavelength, A wavelength detecting means which detects a gap with wavelength which does the minimum loss of this spectral separation means, and wavelength of said semiconductor laser, Wavelength multiplexing transmission equipment changing a sending signal to a semiconductor laser of said reserve when it is judged that a decision means judged to be unusual when this wavelength gap becomes beyond an acceptable value, and this decision means are unusual.

[Claim 14]Several semiconductor lasers which differ in an oscillation wavelength, and two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to said two or more semiconductor lasers differs, A modulation means which carries out intensity modulation of the outputted ray of said half-**** laser based on an AC signal from said AC signal source, respectively, A multiplexing means to multiplex an outputted ray of said semiconductor laser and to acquire a wavelength-multiplexing-light signal, A photoelectric conversion means which receives - part of a wavelength-multiplexing-light signal from said multiplexing means, and is changed into an electrical signal, An extraction means to extract a frequency component of an AC signal generated from said two or more AC signal sources from an output signal of said photoelectric conversion means, respectively, Wavelength-multiplexing-light transmission equipment being constituted by control means which controls each oscillation wavelength of said semiconductor laser on wavelength which does the minimum loss of said multiplexing means based on a frequency component extracted by said extraction means.

[Claim 15]Several semiconductor lasers which differ in an oscillation wavelength, and two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to said two or more semiconductor lasers differs, A modulation means which carries out intensity modulation of the outputted ray of said semiconductor laser based on an AC signal from said AC signal source, respectively, A multiplexing means to multiplex an outputted ray of said semiconductor laser and to acquire a wavelength-multiplexing-light signal, A photoelectric conversion means which receives - part of a wavelength-multiplexing-light signal from said multiplexing means, and is changed into an electrical signal, An extraction means to extract a frequency component of an AC signal generated from said two or more AC signal sources from an output signal of said photoelectric conversion means, respectively, A control means which controls an oscillation wavelength of said semiconductor laser on wavelength which does the minimum loss of said multiplexing means based on a frequency component extracted by said extraction means, Wavelength-multiplexing-light transmission equipment when more than a predetermined number of the oscillation wavelength control to said two or more semiconductor lasers by said control means is control to a uniform direction, wherein said multiplexing means is constituted by a means to judge that it is unusual.

[Claim 16]Wavelength-multiplexing-light transmission equipment being constituted by control means characterized by comprising the following.
Several semiconductor lasers in which oscillation wavelengths differ.
said two or more cows -- a conductor -- two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to laser differs.
A modulation means which carries out intensity modulation of the outputted ray of said semiconductor laser based on an AC signal from said AC signal source, respectively.
A multiplexing means with the controllable transmitted wave length characteristic of multiplexing an outputted ray of said semiconductor laser and acquiring a wavelength-multiplexing-light signal, A photoelectric conversion means which receives - part of a wavelength-multiplexing-light signal from said multiplexing means, and is changed into an electrical signal, An extraction means to extract a frequency component of an AC signal generated from said two or more AC signal sources from an output signal of said photoelectric conversion means, respectively, By said extraction means. Based on an extracted frequency component, an oscillation wavelength of said semiconductor laser. The 2nd control facility that controls the transmitted wave length characteristic of said multiplexing means when more than a predetermined number of the oscillation wavelength control to said two or more semiconductor lasers by the 1st control facility controlled on wavelength which does the minimum loss of said multiplexing means, and this 1st control facility is control to a uniform direction.

[Claim 17]Wavelength-multiplexing-light transmission equipment comprising:
Several semiconductor lasers in which oscillation wavelengths differ.
Two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to said two or more semiconductor lasers differs.
A modulation means which carries out intensity modulation of the outputted ray of said semiconductor laser based on an AC signal from said AC signal source, respectively.
A multiplexing means to multiplex an outputted ray of said semiconductor laser and to acquire a wavelength-multiplexing-light signal, A photoelectric conversion means which receives - part of a wavelength-multiplexing-light signal from said 1000 steps of multiplexing, and is changed into an electrical signal, An extraction means to extract a frequency component of an AC signal generated from said two or more AC signal sources from an output signal of said photoelectric conversion means, respectively, A detection means to detect outside air temperature, Based on a frequency component extracted by said extraction means, an oscillation wavelength of said semiconductor laser by the 1st control facility controlled on wavelength which does the minimum loss of said multiplexing means, and said detection means. A control means which has the 2nd control facility that controls this multiplexing means to compensate the

temperature characteristics of said multiplexing means based on outside-air-temperature change detected.

[Claim 18]Optical repeater which relays a wavelength-multiplexing-light signal transmitted to any 1 of claims 14 thru/or 17 from wavelength-multiplexing-light transmission equipment of a statement, comprising:
An optical fiber amplifier.
A photoelectric conversion means which receives - part of an output of said optical fiber amplifier, and is changed into an electrical signal.
An extraction means to extract a frequency component of an AC signal generated from two or more AC signal sources of wavelength-multiplexing-light transmission equipment from an output signal of said photoelectric conversion means, respectively.
Two or more detection means which detect power of each frequency component extracted by said extraction means, and a control means which controls a gain of said optical fiber amplifier based on an output of said detection means.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the optical repeater which starts the lightwave transmission system which used wavelength multiplexing (Wavelength Division Multiplexing:WDM) art, especially is used combining wavelength-multiplexing-light transmission equipment and this.
[0002]
[Description of the Prior Art]In recent years, research of a long distance and mass transmission is briskly done with progress of an optical fiber amplifier. Especially, since the wavelength-multiplexing-light transmission system can increase the whole transmission capacity by leaps and bounds by carrying out multiplex [of the lightwave signal] in a wavelength area, without raising the transmission capacity per channel, it attracts attention as a very attractive method.
[0003]When performing multiplex for a lightwave signal with high density on a wavelength (or frequency) axis, in order that change of a transmission wave length and the wavelength characteristic of an optical multiplexer/demultiplexer may cause receiving sensitivity degradation, the wavelength surveillance in the whole system including a transmission section and a receive section is indispensable art.
[0004]Conventionally, the surveillance of the transmission wave length was performed by monitoring the operating temperature, the inrush current, and output power of the semiconductor laser used as a light source. However, in surveillance intelligence like this, it cannot respond to the long term deterioration of a semiconductor laser.
[0005]Then, it considers monitoring the oscillation wavelength of a semiconductor laser, using an optical resonator etc. as a wavelength standard machine, performing feedback control to an inrush current or operating temperature, and performing wavelength stabilizing of a semiconductor laser (for example, JP,64-15992,A). In such wavelength stabilizing, it is

multiplexed by an optical coupler, and the outputted ray of a semiconductor laser is transmitted to an optical fiber as a wavelength-multiplexing-light signal, and the part is combined with a Mach-Zehnder interferometer. Based on the outputted ray of this Mach-Zehnder interferometer, package control of the wavelength of a semiconductor laser is carried out.

[0006]However, in such wavelength stabilizing, since nothing was given to the measure when wavelength stabilizing control becomes unstable, when control became unstable and a gap arose in a transmission wave length, the problem of producing receiving sensitivity degradation arose. The light filter for separating each wavelength spectrally in a receive section in wavelength multiplexing transmission is indispensable, and the stability of the wavelength characteristic is dramatically important in respect of receiving sensitivity. Then, the technique of controlling the transmitted wave length characteristic of an optical filter so that the received power after separating spectrally with a light filter serves as the maximum is considered (for example, JP,6-222237,A).

[0007]

[Problem(s) to be Solved by the Invention]In the method of controlling the transmitted wave length characteristic of the above-mentioned conventional optical filter, since the transmitted wave length characteristic of the optical filter was also changed with change of a transmission wave length, the interchannel crosstalk increased and the problem that receiving sensitivity degradation arose arose.

[0008]In the conventional wavelength-multiplexing-light transmission equipment, since measures when wavelength stabilizing operation becomes unstable in a transmission section were not taken, when wavelength control became unstable, the problem that receiving sensitivity degradation arose arose.

[0009]Since the transmitted wave length characteristic of the optical filter of separating a wavelength multiplexing signal light spectrally for every wavelength in a receive section was stabilized to the transmission wave length, when a transmission wave length shifted, the interchannel crosstalk increased, and the problem that receiving sensitivity degradation arose arose.

[0010]In the conventional wavelength-multiplexing-light transmission equipment, Since light corpuscle children, such as a Mach-Zehnder interferometer, were used as a wavelength standard and - ****** was carrying out wavelength of all the semiconductor lasers when performing wavelength stabilizing of a semiconductor laser, there was a problem that the drawing-in range of wavelength was restricted to below a wavelength interval.

[0011]Since temperature dependence existed, a light corpuscle child like a Mach-Zehnder interferometer had the problem that stable wavelength control was difficult, under the influence of outside air temperature. In the about hundreds of [several to] kHz frequency range, since the usual semiconductor laser had very small frequency modulation efficiency, it did not

require frequency modulation, but the problem that wavelength stabilizing was impossible produced it.

[0012]In the optical repeater which receives the conventional wavelength-multiplexing-light signal, since the gain in an optical fiber amplifier changed with number of the lightwave signals wavelength-multiplexing-ized, the problem that stable reception could not be performed arose.

[0013]

[Means for Solving the Problem]The purpose of this invention generates an abnormality alarm, when a wavelength gap with a transmission wave length and wavelength which does the minimum loss of a branching filter becomes beyond an acceptable value, and there is in providing wavelength-multiplexing-light transmission equipment which has a function which prevents receiving sensitivity degradation by wavelength gap.

[0014]Other purposes of this invention detect abnormalities of a transmission wave length in a transmission section, and there are in providing wavelength-multiplexing-light transmission equipment which has a function which prevents receiving sensitivity degradation by wavelength gap.

[0015]Other purposes of this invention supervise a transmission wave length and the transmitted wave length characteristic of an optical multiplexer/demultiplexer, and when the wavelength gap is beyond an acceptable value, and a transmission section and a receive section exchange surveillance intelligence mutually, there are in providing wavelength-multiplexing-light transmission equipment which has the function to pinpoint an abnormal spot.

[0016]Other purposes of this invention control a transmission wave length so that a signal to noise ratio in a receive section serves as the maximum, and there are in providing wavelength-multiplexing-light wavelength multiplexing transmission equipment which can always hold a repressed best receive state of an interchannel crosstalk.

[0017]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment which can continue service, even if abnormalities in a transmission wave length occur inside of inservice.

[0018]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment which has a wavelength stabilizing mechanism independent of frequency of abnormal conditions which the wavelength drawing-in range of a semiconductor laser is not restricted to a wavelength interval, and are performed to a semiconductor laser for wavelength stabilizing.

[0019]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment with little wavelength variation to change of outside air temperature.

[0020]Other purposes of this invention are to provide optical repeater which enables stable reception by a receiver without being dependent on the number of lightwave signals which have multiplexed a wavelength-multiplexing-light signal.

[0021]A branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength according to this invention, A wavelength detector which detects a gap with a receiver which receives an outputted ray of this branching filter, and wavelength and a transmission wave length which do the minimum loss of said branching filter, and outputs a signal according to a wavelength gap, Wavelength-multiplexing-light transmission equipment fundamentally characterized by judging that it is unusual when this wavelength gap becomes beyond an acceptable value, and providing a means to report is provided.
[0022]Several semiconductor lasers which differ in an oscillation wavelength according to this invention, and the 1st Monitoring Department which supervises an operating state of the semiconductor laser, A wavelength standard machine used as a standard of a transmission wave length, and the 2nd Monitoring Department which supervises an oscillation wavelength of said semiconductor laser based on this wavelength standard machine, When an oscillation wavelength of said semiconductor laser produces a gap rather than a wavelength standard machine based on surveillance intelligence from the 1st and 2nd Monitoring Department beyond an acceptable value, wavelength-multiplexing-light transmission equipment possessing a means to judge that it is unusual is provided.
[0023]Several semiconductor lasers which differ in an oscillation wavelength according to this invention, and the 1st Monitoring Department which supervises an operating state of the semiconductor laser, A multiplexing machine which multiplexs an outputted ray of a semiconductor laser and obtains a wavelength multiplexing signal light, and a branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength, A receiver which receives an outputted ray of this branching filter, and a wavelength detector which detects a gap with wavelength and a transmission wave length which do the minimum loss of said branching filter, The 1st judgment part judged to be unusual when this wavelength gap becomes beyond an acceptable value, When this 1st judgment part judges that it is unusual, wavelength-multiplexing-light transmission equipment possessing surveillance intelligence from the 1st Monitoring Department and a means to specify any are more unusual between the transmitting side or a receiver based on an output signal from a wavelength detector is provided.
[0024]The 2nd Monitoring Department which supervises an oscillation wavelength of a semiconductor laser based on a wavelength standard machine used as a standard of a transmission wave length, and this wavelength standard machine according to this invention, The 2nd judgment part judged to be unusual when an oscillation wavelength of a semiconductor laser produces a gap rather than a wavelength standard machine based on surveillance intelligence from said 1st Monitoring Department and the 2nd Monitoring Department beyond an acceptable value, When the 1st judgment part judges that it is unusual,

wavelength-multiplexing-light transmission equipment possessing surveillance intelligence from said 1st and 2nd Monitoring Department and a means to specify any are more unusual between the transmitting side or a receiver based on an output signal of a wavelength detector is provided.

[0025]Two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a multiplexing machine which multiplexs an outputted ray from this semiconductor laser, and obtains a wavelength multiplexing signal light, A wavelength detector which detects an oscillation wavelength of a semiconductor laser from an outputted ray of this multiplexing machine, A control circuit which controls wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine based on an output of this wavelength detector, When the 1st judgment part judges that it is unusual, wavelength-multiplexing-light transmission equipment which specifies any are more unusual between the transmitting side or a receiver based on an output signal from the 1st surveillance intelligence and the 1st wavelength detector, and possesses a means to report is provided.

[0026]Two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a multiplexing machine which multiplexs an outputted ray from this semiconductor laser, and obtains a wavelength multiplexing signal light, A branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength, Wavelength-multiplexing-light transmission equipment possessing a receiver which receives an outputted ray of this branching filter, a means to detect a signal to noise ratio in this receiver, and a control circuit which controls a transmission wave length so that a detected signal to noise ratio serves as the maximum is provided.

[0027]Two or more semiconductor lasers which have different wavelength according to this invention, and a semiconductor laser of a reserve which has different wavelength from these, A multiplexing machine which multiplexs an outputted ray of a semiconductor laser and obtains a wavelength multiplexing signal light, and an optical fiber which transmits this wavelength multiplexing signal light, A wavelength detector which detects a gap with a branching filter which separates a wavelength multiplexing signal light spectrally for every wavelength, and wavelength which does the minimum loss of this branching filter and wavelength of a semiconductor laser, Wavelength-multiplexing-light transmission equipment possessing a judgment part judged to be unusual when this wavelength gap becomes beyond an acceptable value, and a switch part which changes a sending signal to a spare semiconductor laser when this judgment part judges that it is unusual is provided.

[0028]Two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a semiconductor laser of these

plurality differs, A modulation means which carries out intensity modulation of the outputted ray of a semiconductor laser based on an AC signal from these AC signal sources, respectively, A multiplexing means to multiplex an outputted ray of a semiconductor laser and to obtain a wavelength multiplexing signal light, A photoelectric conversion means which receives a part of wavelength multiplexing signal light from this multiplexing means, and is changed into an electrical signal, A means to extract a frequency component of an AC signal generated from two or more AC signal sources from an output signal of this photoelectric conversion means, respectively, Based on a frequency component extracted by this means, wavelength multiplexing transmission equipment possessing a control means which controls each oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing means is provided.

[0029]According to this invention, apart from the 1st control facility that controls an oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine, to wavelength-multiplexing-light transmission equipment, When more than a predetermined number of the oscillation wavelength control to two or more semiconductor lasers twisted to this 1st control facility is control to a uniform direction, a control section which has the 2nd control facility that controls the transmitted wave length characteristic of a multiplexing machine is provided.

[0030]According to this invention, apart from the 1st control facility that controls an oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine, to wavelength-multiplexing-light transmission equipment, Outside air temperature is detected and a control section which has the 2nd control facility that controls a multiplexing machine to compensate the temperature characteristics of a multiplexing machine based on outside-air-temperature change is provided.

[0031]An optical fiber amplifier which amplifies a wavelength-multiplexing-light signal transmitted from wavelength-multiplexing-light transmission equipment according to this invention, A photoelectric conversion part which receives - part of an output of this optical fiber amplifier, and is changed into an electrical signal, A means to extract a frequency component of an AC signal generated from two or more AC signal sources of wavelength-multiplexing-light transmission equipment from an output signal of this photoelectric conversion part, respectively, Optical repeater possessing two or more detection means which detect power of each frequency component extracted by this means, and a control means which controls a gain of said optical fiber amplifier based on an output of these detection means is provided.

[0032]

[Function]In the wavelength-multiplexing-light transmission equipment concerning this invention, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is supervised, and if the wavelength and the

transmission wave length which do the minimum loss of a branching filter are in agreement, receiving sensitivity degradation by an interchannel crosstalk will be suppressed by the minimum. Therefore, if an abnormal signal is generated when the above-mentioned wavelength gap becomes beyond an acceptable value, receiving sensitivity degradation by wavelength gap can be prevented.

[0033]The operating temperature of the semiconductor laser used as a light source in the transmission section in the wavelength-multiplexing-light transmission equipment concerning this invention, If abnormalities are observed by the operating state of a semiconductor laser when in addition to the surveillance of the operating state of inrush current **** output power the oscillation wavelength of each semiconductor laser is supervised using a wavelength standard machine and the oscillation wavelength of a semiconductor laser shifts from a wavelength standard machine, it can be judged that a semiconductor laser is unusual. If there are no abnormalities in the operating state of a semiconductor laser, it can be judged that a wavelength standard machine is unusual. Therefore, it can be judged from all such surveillance intelligence whether the thing with an unusual oscillation wavelength or wavelength standard machine of a semiconductor laser is unusual.

[0034]operating states, such as operating temperature of the semiconductor laser used as a light source in the transmission section in the wavelength-multiplexing-light transmission equipment concerning this invention, and inrush current **** output power, -- supervising -- **** . In a receive section, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is supervised. When a wavelength gap is observed in a receive section, if abnormalities are observed by the operating state of a semiconductor laser, a transmission section will judge that it is unusual, and it can be judged that they are the abnormalities of a receive section except it. Therefore, pinpointing of an abnormal spot can be performed by judging synthetically from such surveillance intelligence.

[0035]In a transmission section, the oscillation wavelength of each semiconductor laser is supervised using a wavelength standard machine, and the specific accuracy of an abnormal spot improves by adding this surveillance intelligence as a judgment source.

[0036]In the wavelength-multiplexing-light transmission equipment concerning this invention, in a receive section, supervise the signal to noise ratio of an input signal, and the signal to noise ratio of an input signal, Since it is an important indicator which determines receiving sensitivity, the best receive state with few channel question cross talks is realizable by controlling a transmission wave length so that a signal to noise ratio serves as the maximum.

[0037]In the wavelength-multiplexing-light transmission equipment concerning this invention, when abnormalities occur in a transmission wave length the inside of inservice, service is changed to the transmitter of the reserve which has another wavelength. Therefore, service is

continuable even if the abnormalities in a transmission wave length occur the inside of inservice.
[0038]In the wavelength-multiplexing-light transmission equipment concerning this invention, the penetration characteristic of the multiplexing machine is used as a wavelength standard. When a multiplexing machine multiplexs, and outputs the light inputted into two or more ON KAPOTO to one output port and an output port is seen from one input port, since only one exists, the wavelength which does the minimum loss, The wavelength drawing-in range of a semiconductor laser is not restricted to a wavelength interval, and is secured to the range covering large frequency.
[0039]In this invention, intensity modulation of the abnormal conditions performed to each semiconductor laser for wavelength stabilizing is carried out. Over a wide frequency range, since it is flat, it does not depend for the intensity modulation efficiency of the usual semiconductor laser on the frequency of the modulating signal applied to a semiconductor laser.
[0040]It is judged as that from which the characteristic of the multiplexing machine which is a wavelength standard shifted, and when more than a predetermined number shifts to the long wavelength or short wavelength side simultaneously among each semiconductor laser by which wavelength control is carried out, alarm etc. are generated or the wavelength penetration characteristic of a multiplexing machine is controlled by this invention. This holds a wavelength standard uniformly and stable wavelength control becomes possible.
[0041]Stable wavelength control becomes possible to change of outside air temperature by controlling a multiplexing machine by this invention to perform outside-air-temperature detection and to compensate the temperature characteristics of the multiplexing machine accompanying outside-air-temperature change.
[0042]By detecting the power of the lightwave signal which the wavelength-multiplexing-light signal has multiplexed, and on the other hand, controlling the gain of an optical fiber amplifier by optical repeater concerning this invention based on it, mail arrival light power is not based on the number of the lightwave signals to multiplex, but becomes fixed, and the stable reception of it is attained.
[0043]
[Embodiment of the Invention]Hereafter, the example of this invention is described based on a drawing.
[0044]In the wavelength-multiplexing-light transmission equipment according to the 1st example of this invention shown in drawing 1, the transmission section T and the receive section R are combined by the optical fiber OF. The transmission section T is optically combined with two or more semiconductor laser (LD) 10_1 which outputs the laser beam of a different oscillation wavelength, respectively, 10_2, --, 10_N, and these semiconductor lasers,

respectively, By transmission signal source 11 $_1$, 11 $_2$, --, sending-signal S_1 from 11 $_N$, S_2, --, S_N. It is constituted by optical modulator 12 $_1$ which modulates a laser beam, respectively, 12 $_2$, --, 12 $_N$ and the multiplexing machine 13 which multiplexes the modulated light from an optical modulator.

[0045]The receive section R receives the multiplexing laser beam sent via the optical fiber OF from the transmission section T, It is connected to two or more outputting parts of the branching filter 21 separated spectrally for every wavelength, and this branching filter, respectively, and comprises two or more receiver 22 $_1$ which changes the receiving laser beam of different wavelength into an electrical signal, respectively, 22 $_2$, --, 22 $_N$. It is connected to the output terminal of a receiver, and if the gap of the wavelength detector 23 and wavelength which detects gap deltalambda of a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 exceeds an acceptable value based on the transmitted wave length characteristic of the branching filter 21, the alarm generator 24 which generates alarm is prepared for this receive section R.

[0046]In the wavelength-multiplexing-light transmission equipment of the above-mentioned composition, If the outputted ray of semiconductor laser (LD) 10 $_1$, 10 $_2$, --, oscillation wavelength $lambda_1$ from which 10 $_N$ differs, $lambda_2$, --, $lambda_N$ is outputted to optical modulator 12 $_1$, 12 $_2$, --, 12 $_N$, Optical modulator 12 $_1$, 12 $_2$, --, 12 $_N$ modulate laser output light according to sending-signal S_1, S_2, --, S_N, respectively. Modulated light is inputted into the multiplexing machine 13, and wavelength multiplexing is carried out here. The output of the multiplexing machine 13 is transmitted to the receive section R via the optical fiber OF.

[0047]In the receive section R, a wavelength multiplexing signal light is separated spectrally for every wavelength with the branching filter 21, and it is received by receiver 22 $_1$, 22 $_2$, --, 22 $_N$, respectively. A part of receiver 22 $_1$, 22 $_2$, --, signal received by 22 $_N$ are inputted into the wavelength detector 23, and gap deltalambda of a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 is detected based on the transmitted wave length characteristic of the branching filter 11. When wavelength gap deltalambda detected with the wavelength detector 20 becomes beyond an acceptable value, the wavelength detector 20 sends out an abnormal signal to the alarm generator 30, and generates alarm.

[0048]Thus, the wavelength multiplexing transmission equipment of this example can prevent receiving sensitivity degradation by wavelength gap by generating alarm, when the wavelength gap with a transmission wave length and the spectral separation characteristic of a branching filter is detected and a wavelength gap becomes beyond an acceptable value.

[0049]The receive section R of wavelength multiplexing transmission equipment according to the 2nd example of this invention is shown in drawing 2. According to this example, it is constituted by receiver 22 $_1$ and -- which receive the optical signal from the branching filter 21, the data reproduction machine 22b by which each of 22 $_N$ was connected to the photoelectric converter 22a and the outgoing end of this photoelectric converter 22a, and the receiving level detector 22c. The wavelength detector 23 is selectively connected to a receiver via receiver 22 $_1$, --, the switching circuit 23a and the switching circuit 23a that are connected to the output terminal of each receiving level detector 22c of 22 $_N$, It is constituted by the controller 23c connected to the output terminal of the comparator 23b which measures a received signal level and the reference voltage ref, and this comparator 23b.
[0050]According to the receive section R of the above-mentioned composition, it is separated spectrally for every wavelength with the optical separator 21, and the lightwave signal sent via the optical fiber OF from the transmission section T is inputted into receiver 22 $_1$, --, 22 $_N$, respectively. Spectral separation light is changed into an electrical signal by the photoelectric converter 22a in each receiver. The output of a photoelectric converter dichotomizes, the method of - is inputted into the data reproducing part 22b, and it is reproduced as send data. Another side is inputted into the receiving level detector 22c. The receiving level detector 22c detects the power of received spectral separation light based on an input signal, and outputs the voltage according to the power of received spectral separation light.
[0051]The output voltage of the receiving level detector 22c is inputted into the wavelength detector 23. By the wavelength detector 23, only one channel is chosen by the switching circuit 23a according to the control signal from the controller 23c, and the voltage signal of the selected channel is compared with the reference voltage ref corresponding to the acceptable value of the wavelength gap in the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and the controller 23c sends out an abnormal signal to the alarm generator 24, when a receiving level detector output becomes below reference voltage. In the alarm generator 24, alarm is generated based on the abnormal signal from the controller 23c.
[0052]By composition shown in drawing 2, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the optical separator 21 can be detected using the transmitted wave length characteristic of the optical separator 21, and abnormalities can be reported.
[0053]The receive section R of wavelength multiplexing transmission equipment according to the 3rd example of this invention is shown in drawing 3. In explanation of this example, identical codes are given to the example and identical parts of drawing 2, and that explanation is omitted.

[0054]The output of the receiving level detector 22a is inputted into the wavelength detector 23, only one channel is chosen by the switching circuit 23a according to the control signal from the controller 23c, and a detect output is measured with a certain programmed voltage by the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and the controller 23c will output a control signal to the branching filter control section 25, if a receiving level becomes smaller than a programmed voltage in the comparator 23b. In the branching filter control section 25, the operating temperature of the branching filter 21 is changed according to the control signal from the controller 23c, and the transmitted wave length characteristic of the branching filter 21 is shifted so that the output of the receiving level detector 22c may serve as the maximum. In this case, the Peltier device is attached to the branching filter 21, and the operating temperature of the branching filter 21 is controlled by this Peltier device.
[0055]The branching filter control section 25 outputs the output voltage according to the variation (shift amount of the transmitted wave length characteristic) of the operating temperature of the branching filter 21 to the controller 23c. In the controller 23c, a wavelength gap is detected from the output voltage from the branching filter control section 25, and when the wavelength gap is beyond an acceptable value, an abnormal signal is outputted to the alarm generator 24.
[0056]Also by composition of this 3rd example, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of an optical separator is detectable using the transmitted wave length characteristic of an optical separator.
[0057]The wavelength-multiplexing-light transmission equipment according to the 4th example of this invention is shown in drawing 4. In this example, identical codes are given to drawing 1 thru/or the example and identical parts of drawing 3, and that explanation is omitted.
[0058]In this example, it is inputted into the wavelength detector 23, only one channel is chosen in the switching circuit 23a, and the output of the receiving level detector 22c of each receiver is measured with a certain programmed voltage by the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and if a receiving level becomes smaller than a programmed voltage, the controller 23c sends out a wavelength control signal to the wavelength control section 26 via the control signal dedicated line L.
[0059]An oscillation wavelength is controlled by the wavelength control section 26 by changing the operating state (for example, operating temperature) of semiconductor laser 10_1, 10_2, -- 10_N so that the output of the receiving level detector 22c may serve as the maximum according to a wavelength control signal. Semiconductor laser 10_1, 10_2, --10_N send out the variation of an operating state to the receive section R as a - part of data.
[0060]In the receive section R, since the variation of the operating state of a semiconductor

laser is transmitted as some data, the variation of the operating state of a semiconductor laser is detected not with the receiving level detector 22c but with the data reproduction machine 22b. The variation detected with the data reproduction machine 22b is sent out to the controller 23c, and a wavelength gap is detected. That is, in the controller 23c, a wavelength gap of the channel is detected from the variation (variation of an outputted ray level) of the operating state of a semiconductor laser, and if this is beyond an acceptable value, the controller 23c will output an abnormal signal to the alarm generator 24.

[0061]In this case, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected from change of the operating state of a semiconductor laser.

[0062]Although detection of the receiving level was performed in the above-mentioned example by detecting the optical power level after a laser beam penetrates the branching filter 21, Intensity modulation of the outputted ray of a semiconductor laser is carried out with the AC signal which has different frequency for every semiconductor laser, and it may carry out by extracting each of that ingredient.

[0063]In the above-mentioned example, although the wavelength control signal was sent out via the control signal dedicated line, it may send out via the communication line which counters.

[0064]With reference to drawing 5, the receive section of the wavelength-multiplexing-light transmission equipment of the 5th example of this invention is explained.

[0065]In this example, the wavelength multiplexing signal light transmitted via the optical fiber OF is amplified with the light amplifier 31. - part branching of the outputted ray of the light amplifier 31 is carried out with the coupler 32, it is inputted into the light power detector 33, and the remainder is inputted into the branching filter 21. In the light power detector 334, the output light power of the light amplifier 31 is detected, and the voltage according to the detected light power is outputted to the gain control machine 34. The gain control machine 34 controls the gain of the light amplifier 31 so that the output light power of the light amplifier 31 becomes fixed. The branching filter 21 separates a wavelength multiplexing signal light spectrally for every wavelength, and inputs it into receiver 22_1, --, 22_N respectively. In each receiver, a reception beam is changed into an electrical signal and a receiving level is detected. The wavelength detector 23 detects the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 from the detected receiving level, and when this gap is beyond an acceptable value, it outputs an abnormal signal to the alarm generator 24.

[0066]In this example, since the input light power to the branching filter 21 is kept constant, change of the optical power level after spectral separation corresponds to the increase in a loss with the branching filter 21 by wavelength gap. Therefore, even if change of the light

power in a transmission line arises, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 is stably detectable.
[0067]Control of a gain is performed by controlling the output power of the pump light of the light amplifier 31. A variable optical attenuator may be formed in the output of the light amplifier 31, and the magnitude of attenuation may be controlled.
[0068]****** is explained to the 6th example of this invention with reference to drawing 6.
[0069]Semiconductor laser 10 $_1$, --, AC signal source 14 $_1$ provided respectively corresponding to 10 $_N$, --, the AC signal of frequency (f_l, --, f_N) with which 14 $_N$ differs are generated. These AC signals are superimposed by the output of bias circuit 16 $_1$, --, 16 $_N$ by adding machine 15 $_1$, --, 15 $_N$, and are poured into semiconductor laser 10 $_1$, --, 10 $_N$. Thereby, according to AC signal source 14 $_1$, --, the AC signal that 14 $_N$ generates, intensity modulation of the outputted ray of semiconductor laser 10 $_1$, --, 10 $_N$ is carried out. Semiconductor laser 10 $_1$, --, after being multiplexed with the multiplexing machine 21, the outputted ray of 10 $_N$ branches in part with the coupler 27, and the wavelength Monitoring Department 40 is presented with it after penetrating the wavelength standard machine 28. An optical resonator etc. are used as the wavelength standard machine 28 here.
[0070]At the wavelength Monitoring Department 40, the output of the photoelectric converter 41, It is inputted into band pass filter 43 $_1$ and -- which have center frequency in the same frequency as AC signal source 14 $_1$, --, the AC signal that 14 $_N$ generates, and 43 $_N$, after being amplified by the amplifier 42 and doing N branching of further. Synchronous detection of the output of these band pass filter 43 $_1$, --, 43 $_N$ is carried out by synchronous detector 44 $_1$, --, 44 $_N$.
[0071]Synchronous detector 44 $_1$, --, after the output of 44 $_N$ removes low pass filter part 45 $_1$, --, a high frequency component unnecessary at 45 $_N$, it is inputted into the microprocessor 46. In the microprocessor 46, based on the synchronous detection output value inputted via a low pass filter, semiconductor laser 10 $_1$, --, the wavelength gap with 10 $_N$ and the wavelength which does the minimum loss of the multiplexing machine 21 are detected, and the voltage according to the wavelength gap is outputted to the abnormality judgment part 47. The abnormality judgment part 47 outputs an abnormal signal to the alarm generator 48, when a wavelength gap becomes beyond an acceptable value. In the alarm generator 48, if an abnormal signal is received, alarm will be generated, and it notifies outside.
[0072]In this example, since alarm is emitted when a wavelength gap of a transmission wave length is detected and the wavelength gap becomes beyond an acceptable value, receiving

sensitivity degradation by wavelength gap can be prevented.
[0073]Although the wavelength standard machine was used in the above-mentioned example, the transmitted wave length characteristic of a multiplexing machine may be used as a wavelength standard machine.
[0074]The transmission section T of wavelength multiplexing transmission equipment which followed the 7th example of this invention with reference to drawing 7 is explained. In this example, identical codes are given to the example and identical parts of drawing 6, and the explanation is omitted.
[0075]It is multiplexed in the outputted ray of semiconductor laser 10_1, --, 10_N with the multiplexing machine 13. - part of the output of the multiplexing machine 13 is inputted into the wavelength Monitoring Department 40 with the coupler 27. At the wavelength Monitoring Department 40, each semiconductor laser 10_1, --, the wavelength gap with the oscillation wavelength of 10_N and the wavelength which does the minimum loss of the multiplexing machine 13 are detected, and the voltage corresponding to the wavelength gap is outputted to the abnormality judgment part 47.
[0076]Operating state Monitoring Department 17_1, ..., 17_N supervise the operating state of the operating temperature, the inrush current, and output power of each semiconductor laser, and output the information to the abnormality judgment part 47. From the surveillance intelligence from the operating state Monitoring Department, and the information about the wavelength gap from the wavelength Monitoring Department, the abnormality judgment part 47 judges a gap of a transmission wave length or a gap of the wavelength characteristic of a multiplexing machine, and when the gap is beyond an acceptable value, it outputs an abnormal signal.
[0077]In this example, since the information about the operating state of a semiconductor laser is also used for unusual judgment, it can be presumed whether the oscillation wavelength of a semiconductor laser is unusual, and whether the wavelength characteristic of the multiplexing machine used as a wavelength standard is unusual.
[0078]The wavelength-multiplexing-light transmission equipment of the 8th example of this invention is explained to drawing 8.
[0079]In this example, each semiconductor laser 10_1, --, operating state Monitoring Department in which 10_N supervises operating states, such as that operating-temperature, actuating current, and output power, 17_1, --, 17_N are provided. Each operating state Monitoring Department outputs the supervisory signal according to the operating temperature, actuating current, and output power of the semiconductor laser to the abnormality judgment part 47.

[0080]It is multiplexed with the multiplexing machine 13 and the outputted ray of semiconductor laser 10_1, --, 10_N is transmitted via the optical fiber OF. It is separated spectrally for every wavelength with the branching filter 21, and the wavelength multiplexing signal light transmitted via the optical fiber OF is received by optical receiver 22_1, --, 22_N. The wavelength detector 23 sends out an abnormal signal to the abnormality judgment part 47 via the control signal dedicated line L, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected based on the receiving level of each optical receiver and a wavelength gap becomes beyond an acceptable value. The abnormality judgment part 47 judges the abnormal signal from the wavelength detector 23, operating state Monitoring Department 17_1, being --, being a thing with a transmission wave length unusual based on the surveillance intelligence from 17_N, and whether a branching filter is unusual. It not only detects a wavelength gap, but in this example, since it judges any are more unusual between the transmission section T and the receive section R, it can pinpoint an abnormal spot. In this example, although the control signal dedicated line L was used for transfer of the abnormal signal from a wavelength detector to the abnormality judgment part 47, the communication line which counters may be used.
[0081]The wavelength-multiplexing-light transmission equipment of the 9th example of this invention is explained to drawing 9. In this example, identical codes are given to the example and identical parts of drawing 8, and that explanation is omitted.
[0082]It is multiplexed in the outputted ray from semiconductor laser 10_1, --, 10_N with the multiplexing machine 13. - part of the outputted ray from the multiplexing machine 13 branches with the coupler 32, and is inputted into the wavelength Monitoring Department 40. At the wavelength Monitoring Department 40, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the multiplexing machine 13 is supervised by making the transmitted wave length characteristic of the multiplexing machine 13 into a wavelength standard, and the output signal according to this wavelength gap is outputted to the abnormality judgment part 47. In the abnormality judgment part 47, if the abnormal signal from the wavelength detector 23 is received, this abnormal signal, operating state Monitoring Department 17_1, --, a thing with a transmission section unusual based on the supervisory signal from 17_N and the supervisory signal from the wavelength Monitoring Department 41, and a receive section will judge whether it is unusual.
[0083]In this example, since the surveillance intelligence of the transmission wave length is also used as a decision criterion, precision improvement of abnormal spot specification can be planned.
[0084]The wavelength-multiplexing-light transmission equipment of the 10th example of this

invention is explained to drawing 10. In this example, identical codes are given to drawing 8, and the example and identical parts of drawing 9, and that explanation is omitted.
[0085]Semiconductor laser 10 $_1$, --, AC signal source 14 $_1$ provided respectively corresponding to 10 $_N$, --, the AC signal of frequency (f_1, f_2, --, f_N) with which 14 $_N$ differs are generated. These AC signals are superimposed by the output of bias circuit 16 $_1$, --, 16 $_N$ by adding machine 15 $_1$, --, 15 $_N$, and are poured into semiconductor laser 10 $_1$, --, 10 $_N$. Thereby, according to AC signal source 14 $_1$, --, the AC signal that 14 $_N$ generates, intensity modulation of the outputted ray of semiconductor laser 10 $_1$, --, 10 $_N$ is carried out.
[0086]- part branching is carried out with the coupler 32, and the outputted ray of 10 $_N$ is inputted into the photoelectric converter 41, after being multiplexed with the multiplexing machine 13, semiconductor laser 10 $_1$, --,. After the output of the photoelectric converter 41 is amplified by the amplifier 42 and N branching of it is done further, it is inputted into band pass filter 43 $_1$ and -- which have center frequency in the same frequency as AC signal source 14 $_1$, --, the AC signal that 14 $_N$ generates, and 43 $_N$. Synchronous detection of the output of these band pass filters is carried out by synchronous detector 44 $_1$, --, 44 $_N$. After the output of a synchronous detector removes low pass filter 45 $_1$, --, a high frequency component unnecessary at 45 $_N$, it is inputted into the microprocessor 46. In a microprocessor part, based on the synchronous detection output value inputted via a low pass filter, so that the oscillation wavelength of 10 $_N$ may turn into semiconductor laser 10 $_1$, --, wavelength that does the minimum loss of the multiplexing machine 13, The temperature of semiconductor laser 10 $_1$, --, 10 $_N$ is controlled. The wavelength stabilizing of a semiconductor laser is realizable by this control.
[0087]Each semiconductor laser 10 $_1$, --, the operating state of the operating temperature, the inrush current, and output power of 10 $_N$ are supervised by operating state Monitoring Department 17 $_1$, --, 17 $_N$.
[0088]On the other hand, it is separated spectrally for every wavelength with the branching filter 21, and the wavelength multiplexing signal light transmitted via the optical fiber OF is received by optical receiver 22 $_1$, --, 22 $_N$. The wavelength detector 23 sends out an abnormal signal to the abnormality judgment part 47 via the control signal dedicated line L, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected based on the receiving level of each optical receiver and

this wavelength gap becomes beyond an acceptable value. The abnormality judgment part 47 judges the abnormal signal from the wavelength detector 23, operating state Monitoring Department 17_1, being --, being a thing with a transmission wave length unusual based on the surveillance intelligence from 17_N, and whether a branching filter is unusual.

[0089]Since each transmission wave length is stabilized by the wavelength which does the minimum loss of a multiplexing machine, what is necessary will be to detect only the wavelength gap with the wavelength characteristic of a multiplexing machine, and the wavelength characteristic of a branching filter in a wavelength detector in this example. Therefore, simplification of a wavelength monitoring function can be attained.

[0090]Furthermore based on the surveillance intelligence from operating state Monitoring Department 17_1, --, 17_N, the abnormalities of each semiconductor laser 10_1, --, 10_N are detectable.

[0091]The wavelength-multiplexing-light transmission equipment of the 11th example of this invention is explained to drawing 11.

[0092]It is multiplexed with the multiplexing machine 13 and the outputted ray from semiconductor laser 10_1, --, 10_N turns into a wavelength multiplexing signal light. The wavelength multiplexing signal light transmitted via the optical fiber OF is respectively received by optical receiver 22_1, --, 22_N, after being separated spectrally for every wavelength with the branching filter 21. The signal-to-noise-ratio test section 51 is presented with - part of the output of each optical receiver. In the signal-to-noise-ratio test section 51, the signal to noise ratio of an input signal is measured, and a feedback control signal is sent out to a transmission section via the control signal dedicated line L so that this ratio may serve as the maximum. The wavelength control section 52 controls the transmission wave length of each semiconductor laser according to this control signal. Since according to this example a transmission wave length is controlled so that the signal to noise ratio in each optical receiver serves as the maximum, the signal transmission in the state of becoming the minimum of the cross talk from other channels becomes possible. Although the feedback control signal was sent out via the control signal dedicated line in this example, it may send out via the communication line which counters. The example of the signal-to-noise-ratio system of measurement is shown in drawing 12. According to this, the lightwave signal of each wavelength (lambdai, i= 1, 2, --, N) separated spectrally with the branching filter is changed into an electrical signal with the photoelectric converter 61i (i= 1, --, N), and after being amplified with the amplifier 62i, it trifurcates. The branched signal is inputted into the 1st discrimination decision circuit 63i, 2nd discrimination decision circuit 64i, and clock extraction circuit 65i, respectively. A clock extraction circuit carries out the ejection of the clock component of a transmission signal, and supplies a clock signal to the 1st and 2nd discrimination decision circuits 63i and 64i. In the 1st

discrimination decision circuit 63i, optimization of discernment RE ** RU is made.
The transmitted data is reproduced.
On the other hand, in the 2nd discrimination decision circuit 64i, a discrimination level is changed based on the control signal from the microprocessor 67i, and data is reproduced based on the discrimination level. The exclusive OR circuit 66i takes the exclusive OR of the data reproduced in the 1st and 2nd discrimination decision circuits 63i and 64i. The microprocessor 67i calculates Q value based on the output of the exclusive OR circuit 66i, and outputs the voltage corresponding to the calculated Q value to the signal-to-noise-ratio test section 51. In the signal-to-noise-ratio test section 51, the signal to noise ratio of a sending signal is calculated based on a formula (1) from the calculated Q value.
[0093]Q=20log (S/N) -- - (1)
Measurement of the signal to noise ratio of a sending signal is attained with constituting in this way.
[0094]The wavelength-multiplexing-light transmission equipment of the 13th example concerning this invention is explained to drawing 13.
[0095]According to this example, each sending-signal S_l, S_2, --, S_N are inputted into optical modulator 12_1, --, 12_N via switching circuit 18_1, --, 18_N. It has semiconductor laser 10_1, --, oscillation wavelength [from which 10_N differs respectively] $lambda_1$, $lambda_2$, ..., and $lambda_N$, and intensity modulation of the outputted ray is carried out by optical modulator 12_1, 12_2, --, 12_N, and it is multiplexed with the multiplexing machine 13. Spare semiconductor laser 10_{N+1} has different oscillation wavelength $lambda_{N+l}$ from the above-mentioned semiconductor laser, and it is multiplexed with the multiplexing machine 13 like the above-mentioned semiconductor laser via optical modulator 12_{N+1}. It is transmitted via the optical fiber OF, and is separated spectrally for every wavelength with the branching filter 21, and the output of the multiplexing machine 13 is received, respectively by optical receiver 22_1, --, 22_N, and 22_{N+1}.
[0096]The wavelength detector 23 detects optical receiver 22_1, --, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter based on each receiving level of 22_N and 22_{N+1}, When this wavelength gap becomes beyond an acceptable value, a switch control section 50 HE abnormal signal is sent out via the control signal dedicated line L.
[0097]In the switch control section 50, reception of this abnormal signal will output a control signal to BE ** which changes the sending signal of the channel judged to be unusual to spare wavelength $lambda_{N+1}$, switch 18_1, --, 18_N and the switch 19.

[0098]According to this example, even if the abnormalities in wavelength occur the inside of inservice, recovery of a system can be aimed at by changing the sending signal of the channel which abnormalities generated to spare wavelength, without interrupting service. In this example, although the abnormal signal was sent out via the control signal dedicated line, it may send out via the communication line which counters. Drawing 14 is a figure showing the composition of the wavelength-multiplexing-light transmission equipment concerning the 14th example of this invention. In the figure, semiconductor laser (LD) 111 $_1$, l11 $_2$, --, AC signal source 112 $_1$ provided respectively corresponding to 111 $_N$, 112 $_2$, --, 112 $_N$, The AC signal of different frequency (f_l, f_2, --, f_N) is generated. Here, frequency f_l, f_2, --, and f_N are set as send data S_1, S_2, --, the low frequency region of S_N out of band. These AC signals are superimposed by the output of bias circuit 114 $_1$, 114 $_2$, --, 114 $_N$ by adding machine 113 $_1$, 113 $_2$, --, 113 $_N$, By semiconductor laser 111 $_1$, l11 $_2$, --, this that is poured into 111 $_N$. According to AC signal source 112 $_1$, 112 $_2$, --, the AC signal that 112 $_N$ generates, intensity modulation of the outputted ray of semiconductor laser 111 $_1$, l11 $_2$, --, 111 $_N$ is carried out.

[0099]The outputted ray of semiconductor laser 111 $_1$, l11 $_2$, --, 111 $_N$, In external modulator 130 $_1$, 130 $_2$, --, 130 $_N$, send data S_1, S_2, --, after S_N becomes irregular, respectively, wavelength multiplexing is carried out with the multiplexing machine 110. The multiplexing machine using the concave grating as the multiplexing machine 110 is used. The wavelength-multiplexing-light signal outputted from the multiplexing machine 110 dichotomizes with the optical coupler 125, after the method of - is amplified by the optical fiber amplifier 140, it is sent out to the optical fiber 100 for transmission, and another side is supplied to the photoelectric converter 125.

[0100]The output of the photoelectric converter 125 is amplified by the amplifier 109, and n branching further After being carried out, AC signal source 112 $_1$, 112 $_2$, --, band pass filter (BPF) 116 $_1$ that has center frequency in the same frequency as the AC signal which 112 $_N$ generates, 116 $_2$, --, 116 $_N$ are supplied. Namely, in band pass filter 116 $_1$, 116 $_2$, --, 116 $_N$. The ingredient of AC signal source 112 $_1$, 112 $_2$, --, same frequency [as the AC signal which 112 $_N$ generates] f_l, f_2, --, f_N is extracted among the outputs of the photoelectric converter 125. The output of these band pass filter 116 $_1$, 116 $_2$, --, 116 $_N$, It can take advantaging by synchronous detector 115 $_1$, 115 $_2$, --, 115 $_N$, respectively with AC signal source 112 $_1$, 112 $_2$, --, the AC signal outputted from 112 $_N$, It is inputted into the microcomputer 20 after an

unnecessary high frequency component is removed by ROHASU filter (LPF) 117_1, 117_2, -- 117_N as for the output of 115_N, synchronous detector 115_1 by which synchronous detection is carried out, 115_2, --,.

[0101]Based on the synchronous detection output value inputted via low pass filter 117_1, 117_2, --117_N, the MAI clo computer 20, The temperature of semiconductor laser 111_1, $l11_2$, --, 111_N is controlled so that the oscillation wavelength of 111_N turns into semiconductor laser 111_1, $l11_2$, --, wavelength that does the minimum loss of the multiplexing machine 110. Wavelength stabilizing of semiconductor laser 111_1, $l11_2$, --, 111_N is realized by this control.

[0102]That is, it is judged whether the synchronous detection output which the synchronous detection output was incorporated and was incorporated as shown in the flow chart of drawing 15 is the maximum. In this judgment, if the incorporated synchronous detection output value is not the maximum, temperature control of semiconductor laser LD will be performed so that it may become the maximum. If it is the maximum, a synchronous detection output will be incorporated again.

[0103]The temperature control system of semiconductor laser LD is shown in drawing 16. According to this, Peltier device PE is attached to semiconductor laser LD as a heating element, this Peltier device PE drives with the driver 121 controlled by the microcomputer 120, and temperature control is carried out. The temperature of semiconductor laser LD is measured by the thermo sensitive register TH attached to Peltier device PE. Measurement temperature is sent to the microcomputer 120 and a semiconductor laser is monitored for temperature.

[0104]The penetration characteristic and the synchronous detection output of the multiplexing machine 110 are shown in drawing 17. If the temperature of semiconductor laser 111_1, $l11_2$, --, 111_N is controlled by the MAI clo computer 120 clearly from the figure so that a synchronous detection output serves as the maximum, semiconductor laser 111_1, $l11_2$, --, oscillation wavelength lambda$_1$ of 111_N, lambda$_2$, -- and . it turns out to be that lambda$_N$ is stabilized by the wavelength which does the minimum loss of the multiplexing machine 110 -- again, As for the transmission loss property over wavelength when each ON KAPOTO of the multiplexing machine 110 to an output port is seen from drawing 17, it turns out that the wavelength which does the minimum loss **** only - **. Therefore, even if it changes to the field of the wavelength of semiconductor laser 111_1, $l11_2$, --, wavelength lambda$_1$ of 111_N, lambda$_2$, --, the semiconductor laser in which lambda$_N$ adjoins, It can draw in desired wavelength semiconductor laser 111_1, $l11_2$, --, by controlling the temperature of 111_N so that

a synchronous detection output may serve as the maximum. That is, it is not dependent on a wavelength interval and the cotton intermediary reservation of the wavelength drawing-in range of semiconductor laser 111_1, 111_2, --, 111_N is carried out in a wide frequency range.

[0105]Thus, since the wavelength drawing-in range is not dependent on a wavelength interval and is secured over the wide range, semiconductor laser 111_1, 111_2, --, the wavelength stabilizing control more stable to 111_N of the wavelength stabilizer of this example are attained.

[0106]In this invention, control which was stabilized regardless of modulation frequency for wavelength stabilizing unlike the frequency modulation used with the conventional wavelength-multiplexing-light transmission equipment since semiconductor laser 111_1, 111_2, --, the abnormal conditions performed to 111_N were intensity modulation can be performed.

[0107]Although temperature was controlled in the above-mentioned example for the wavelength control of semiconductor laser 111_1, 111_2, --, 111_N, wavelength control may be performed by semiconductor laser 111_1, 111_2, --, controlling the inrush current to 111_N.

[0108]When using multielectrode-arrays laser as a semiconductor laser, it may be made to perform wavelength control and output-power control by controlling the inrush current to a semiconductor laser simultaneously.

[0109]Drawing 18 shows the composition of the transmission section of the wavelength-multiplexing-light transmission equipment concerning the 15th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0110]In n branching, the output of the amplifier 109 in this example After being carried out, AC signal source 112_1, 112_2, --, frequency f_l of the AC signal which 112_N generates, f_2, --, band pass filter 116_1 with the same center frequency as f_N, 116_2, --, 116_N are supplied. Namely, in band pass filter 116_1, 116_2, --, 116_N. Among the outputs of the photoelectric converter 125, AC signal source 112_1, 112_2, --, the ingredient of the same frequency as the AC signal which 112_N generates, That is, the frequency component of semiconductor laser 111_1, 111_2, -- and the modulation components of the intensity modulation performed to 111_N, i.e., f_l, f_2, --, f_N is extracted, respectively for wavelength stabilizing. The output of these band pass filter 116_1, 116_2, --, 116_N is detected by wave detector 150_1, 150_2, --, 150_N, respectively. In this case, it has wave detector 150_1, 150_2, --, the characteristic as the synchronous detection output shown in drawing 17 that the detection output of 150_N is the same. . Therefore, the

microcomputer 120 is inputted via low pass filter 117_1, 117_2, --, 117_N. Based on the output of wave detector 150_1, 150_2, --, 150_N, According to the flow chart shown in drawing 15, the temperature of semiconductor laser 111_1, 111_2, --, 111_N is controlled to become semiconductor laser 111_1, 111_2, --, the wavelength that does the minimum loss of the multiplexing machine 110 about the wavelength of 111_N. Thereby, the wavelength stabilizing of semiconductor laser 111_1, 111_2, --, 111_N is realizable like the 14th example.

[0111]Drawing 19 shows the composition of the wavelength-multiplexing-light transmission equipment concerning the 16th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0112]in this example -- all the semiconductor laser 111_1, 111_2, --, 111_N, and ** -- more than a predetermined number among them. For example, when the microcomputer 120 judges more than a moiety that it makes a uniform direction (short wavelength either a long wavelength side or the side the direction of the method of -) consider wavelength as a shift simultaneously, The wavelength of semiconductor laser 111_1, 111_2, --, 111_N did not shift, but it considers that the gap of the abnormalities of the multiplexing machine 110, i.e., the transmitted wave length characteristic, arose, and the microcomputer 120 drives the alarm generator 135 and generates alarm. In such a case, the microcomputer 120 outputs a control signal so that the transmitted wave length characteristic of the multiplexing machine 110 may be adjusted. Here, adjustment of the transmitted wave length characteristic of the multiplexing machine 110 is performed by controlling temperature.

[0113]That is, as shown in the flow chart of drawing 20, a synchronous detection output is incorporated and it is judged whether the incorporated synchronous detection output is the maximum. If this judgment is YES, it will return to the flow of synchronous detection output incorporation, and if it is NO, it will be judged whether the number of the semiconductor lasers which should be carried out a wavelength shift to a uniform direction is more than a predetermined number (N pieces). If this judgment is YES, alarm will be emitted, and if it is NO, temperature control of semiconductor laser LD will be performed.

[0114]By this example, the microcomputer 120 as mentioned above for the wavelength stabilizing of semiconductor laser 111_1, 111_2, --, 111_N, Via low pass filter 117_1, 117_2, --117_N. Semiconductor laser 111_1, 111_2, --, 111_N are controlled so that the oscillation wavelength of 111_N turns into a semiconductor laser, 111_1, 111_2, --, wavelength that does the minimum loss of the multiplexing machine 110 based on the synchronous detection output value inputted, Semiconductor laser 111_1, 111_2, --, when more than the predetermined number of

the oscillation wavelength control to 111_N needs control of a uniform direction, the transmitted wave length characteristic of the multiplexing machine 110 is controlled.

[0115]thus, the thing for which it has the same effect as the 14th example according to this example -- in addition, since the transmitted wave length characteristic of the multiplexing machine 10 can always be kept constant, the effect that more stable wavelength control becomes possible is acquired.

[0116]Drawing 21 is a figure showing the composition of the wavelength-multiplexing-light transmission equipment concerning the 17th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0117]In this example, in addition to the composition of the example of drawing 14, the outside-air-temperature sensing device 160 is formed, and the output signal of this outside-air-temperature sensing device 160 is inputted into the microcomputer 120. Here, the temperature characteristics of the multiplexing machine 110 are known beforehand, and the microcomputer 120 controls the oscillation wavelength of the multiplexing machine 110 to compensate the temperature characteristics of the multiplexing machine 110 based on the signal from the outside-air-temperature sensing device 160.

[0118]That is, as shown in the flow chart of drawing 22, the microcomputer 120 incorporates the outdoor air temperature of the outdoor-air-temperature detector 160, and this temperature judges whether it is in a preset value. If it is outside a preset value (i.e., if it is NO), after performing temperature compensating control to the multiplexing machine 110, temperature control of a semiconductor laser will be performed. If it is YES, temperature control of a semiconductor laser will be performed. In the wavelength control of a semiconductor laser, the microcomputer 120 incorporates a synchronous detection output and judges whether the incorporated synchronous detection output is the maximum. In this judgment, if the incorporated synchronous detection output value is not the maximum, the microcomputer 120 will carry out temperature control of semiconductor laser LD via the temperature control system shown in drawing 16, and if it is the maximum, a synchronous detection output will be incorporated again. In the temperature control of a semiconductor laser, for the wavelength stabilizing of semiconductor laser 111_1, $l11_2$, --, 111_N, Via low pass filter 117_1, 117_2, --117_N. Semiconductor laser 111_1, $l11_2$, --, 111_N are controlled so that the oscillation wavelength of 111_N turns into half-**** laser 111_1, $l11_2$, --, wavelength that does the minimum loss of the multiplexing machine 110 based on the synchronous detection output value inputted.

[0119]therefore, the thing for which it has the same effect as the 14th example also in this example -- in addition, the effect that stable wavelength control becomes possible to outside-air-temperature change is acquired.

[0120]Drawing 23 shows the composition of the optical repeater combined with wavelength-multiplexing-light transmission equipment as the 18th example of this invention.
[0121]The wavelength multiplexing signal transmitted by the optical fiber 100 from the wavelength-multiplexing-light transmission equipment explained in the 14th - the 17th example, The optical fiber amplifier 141 which is amplified by the optical fiber amplifier 141 and with which transmission is again presented by the optical fiber 100 comprises WDM couplers 126, the erbium doped fiber 110, and the light source 180,181 for excitation.
[0122]The outputted ray (wavelength-multiplexing-light signal) from the optical fiber amplifier 141 dichotomizes with the optical coupler 127, and - part is supplied to the photoelectric converter 125, and is changed into an electrical signal. The output of the photoelectric converter 125 is amplified with the amplifier 109, and after n branching of is done, it is supplied to band pass filter 116_1, 116_2, --, 116_N. The passing center frequency of band pass filter 116_1, 116_2, --, 116_N, In wavelength-multiplexing-light transmission equipment, semiconductor laser 111_1, $l11_2$, --, frequency f_l of the AC signal used in order to stabilize the wavelength of 111_N, f_2, --, f_N are supported, respectively. The output of band bus filter 116_1, 116_2, --, 116_N is detected by wave detector 150_1, 150_2, --, 150_N, respectively. The controller 170 controls the gain of the optical FUAIPA amplifier 141 wave detector 150_1, 150_2, --, by controlling the output power of the light source 180,181 for excitation based on the output of 150_N.
[0123]That is, as shown in the flow chart of drawing 24, the controller 170 judges [wave detector 150_1, 150_2, --,] whether each wavelength is in a preset value by incorporating a detection output from 150_N. If output power is in a preset value, the gain of the optical fiber amplifier 141 will be controlled.
[0124]Thus, since according to this example it is not based on the number of the lightwave signals multiplexed as a wavelength-multiplexing-light signal but the gain of the lightwave signal of each wavelength is made to regularity, in a receiving set, mail arrival power becomes always fixed, and stable reception is attained.
[0125]
[Effect of the Invention]As explained above, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter becomes beyond an acceptable value, an abnormal signal is generated in this invention.
Therefore, degradation of the receiving sensitivity by wavelength gap can be prevented.

[0126]Since the abnormalities of a transmission wave length are detected in a transmission section, degradation of the receiving sensitivity by wavelength gap can be prevented.

[0127]An abnormal spot can be pinpointed, when a transmission wave length and the transmitted wave length characteristic of an optical multiplexer/demultiplexer are supervised, the wavelength gap is beyond an acceptable value and a transmission section and a receive section exchange surveillance intelligence mutually.

[0128]Since the transmission wave length is controlled so that the signal to noise ratio in a receive section serves as the maximum, the repressed best receive state of an interchannel crosstalk can always be held.

[0129]Service is continuable even if the abnormalities in a transmission wave length occur the inside of inservice.

[0130]According to this invention, the wavelength drawing-in range is not restricted to a wavelength interval, but wavelength-multiplexing-light transmission equipment with the wavelength stabilizing mechanism independent of the frequency of the modulating signal applied to a semiconductor laser for wavelength stabilizing can be provided.

[0131]When more than a predetermined number shifts to the long wavelength or short wavelength side simultaneously in this invention among each semiconductor laser by which wavelength control is carried out, It is judged as that from which the characteristic of the multiplexing machine which is a wavelength standard shifted, and by generating alarm etc. or controlling the wavelength penetration characteristic of a multiplexing machine, a wavelength standard can be held uniformly and more stable wavelength control can be made possible.

[0132]Stable wavelength control becomes possible to change of outside air temperature by controlling a multiplexing machine by this invention to perform outside-air-temperature detection and to compensate the temperature characteristics of the multiplexing machine accompanying outside-air-temperature change.

[0133]In the optical repeater concerning this invention, the power of the lightwave signal which has multiplexed the wavelength-multiplexing-light signal is detected, Since mail arrival light power is not based on the number of the lightwave signals to multiplex by a receiving set smell but it becomes fixed by controlling the gain of an optical fiber amplifier according to the number of the lightwave signals multiplexed to the wavelength-multiplexing-light signal by which human power is carried out based on it, stable reception is attained.

[Translation done.]

TECHNICAL FIELD

[Industrial Application]This invention relates to the optical repeater which starts the lightwave transmission system which used wavelength multiplexing (Wavelength Division Multiplexing:WDM) art, especially is used combining wavelength-multiplexing-light transmission equipment and this.

[Translation done.]

PRIOR ART

[Description of the Prior Art]In recent years, research of a long distance and mass transmission is briskly done with progress of an optical fiber amplifier. Especially, since the wavelength-multiplexing-light transmission system can increase the whole transmission capacity by leaps and bounds by carrying out multiplex [of the lightwave signal] in a wavelength area, without raising the transmission capacity per channel, it attracts attention as a very attractive method.
[0003]When performing multiplex for a lightwave signal with high density on a wavelength (or frequency) axis, in order that change of a transmission wave length and the wavelength characteristic of an optical multiplexer/demultiplexer may cause receiving sensitivity degradation, the wavelength surveillance in the whole system including a transmission section and a receive section is indispensable art.
[0004]Conventionally, the surveillance of the transmission wave length was performed by monitoring the operating temperature, the inrush current, and output power of the semiconductor laser used as a light source. However, in surveillance intelligence like this, it cannot respond to the long term deterioration of a semiconductor laser.
[0005]Then, it considers monitoring the oscillation wavelength of a semiconductor laser, using an optical resonator etc. as a wavelength standard machine, performing feedback control to an inrush current or operating temperature, and performing wavelength stabilizing of a semiconductor laser (for example, JP,64-15992,A). In such wavelength stabilizing, it is multiplexed by an optical coupler, and the outputted ray of a semiconductor laser is transmitted to an optical fiber as a wavelength-multiplexing-light signal, and the part is combined with a Mach-Zehnder interferometer. Based on the outputted ray of this Mach-Zehnder interferometer, package control of the wavelength of a semiconductor laser is carried out.
[0006]However, in such wavelength stabilizing, since nothing was given to the measure when wavelength stabilizing control becomes unstable, when control became unstable and a gap arose in a transmission wave length, the problem of producing receiving sensitivity degradation

arose. The light filter for separating each wavelength spectrally in a receive section in wavelength multiplexing transmission is indispensable, and the stability of the wavelength characteristic is dramatically important in respect of receiving sensitivity. Then, the technique of controlling the transmitted wave length characteristic of an optical filter so that the received power after separating spectrally with a light filter serves as the maximum is considered (for example, JP,6-222237,A).

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter becomes beyond an acceptable value, an abnormal signal is generated in this invention. Therefore, degradation of the receiving sensitivity by wavelength gap can be prevented.

[0126]Since the abnormalities of a transmission wave length are detected in a transmission section, degradation of the receiving sensitivity by wavelength gap can be prevented.
[0127]An abnormal spot can be pinpointed, when a transmission wave length and the transmitted wave length characteristic of an optical multiplexer/demultiplexer are supervised, the wavelength gap is beyond an acceptable value and a transmission section and a receive section exchange surveillance intelligence mutually.
[0128]Since the transmission wave length is controlled so that the signal to noise ratio in a receive section serves as the maximum, the repressed best receive state of an interchannel crosstalk can always be held.
[0129]Service is continuable even if the abnormalities in a transmission wave length occur the inside of inservice.
[0130]According to this invention, the wavelength drawing-in range is not restricted to a wavelength interval, but wavelength-multiplexing-light transmission equipment with the wavelength stabilizing mechanism independent of the frequency of the modulating signal applied to a semiconductor laser for wavelength stabilizing can be provided.
[0131]When more than a predetermined number shifts to the long wavelength or short wavelength side simultaneously in this invention among each semiconductor laser by which wavelength control is carried out, It is judged as that from which the characteristic of the multiplexing machine which is a wavelength standard shifted, and by generating alarm etc. or controlling the wavelength penetration characteristic of a multiplexing machine, a wavelength

standard can be held uniformly and more stable wavelength control can be made possible.
[0132]Stable wavelength control becomes possible to change of outside air temperature by controlling a multiplexing machine by this invention to perform outside-air-temperature detection and to compensate the temperature characteristics of the multiplexing machine accompanying outside-air-temperature change.
[0133]In the optical repeater concerning this invention, the power of the lightwave signal which has multiplexed the wavelength-multiplexing-light signal is detected, Since mail arrival light power is not based on the number of the lightwave signals to multiplex by a receiving set smell but it becomes fixed by controlling the gain of an optical fiber amplifier according to the number of the lightwave signals multiplexed to the wavelength-multiplexing-light signal by which human power is carried out based on it, stable reception is attained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]In the method of controlling the transmitted wave length characteristic of the above-mentioned conventional optical filter, since the transmitted wave length characteristic of the optical filter was also changed with change of a transmission wave length, the interchannel crosstalk increased and the problem that receiving sensitivity degradation arose arose.
[0008]In the conventional wavelength-multiplexing-light transmission equipment, since measures when wavelength stabilizing operation becomes unstable in a transmission section were not taken, when wavelength control became unstable, the problem that receiving sensitivity degradation arose arose.
[0009]Since the transmitted wave length characteristic of the optical filter of separating a wavelength multiplexing signal light spectrally for every wavelength in a receive section was stabilized to the transmission wave length, when a transmission wave length shifted, the interchannel crosstalk increased, and the problem that receiving sensitivity degradation arose arose.
[0010]In the conventional wavelength-multiplexing-light transmission equipment, Since light corpuscle children, such as a Mach-Zehnder interferometer, were used as a wavelength standard and - ****** was carrying out wavelength of all the semiconductor lasers when performing wavelength stabilizing of a semiconductor laser, there was a problem that the drawing-in range of wavelength was restricted to below a wavelength interval.
[0011]Since temperature dependence existed, a light corpuscle child like a Mach-Zehnder interferometer had the problem that stable wavelength control was difficult, under the influence of outside air temperature. In the about hundreds of [several to] kHz frequency range, since the usual semiconductor laser had very small frequency modulation efficiency, it did not require frequency modulation, but the problem that wavelength stabilizing was impossible produced it.

[0012]In the optical repeater which receives the conventional wavelength-multiplexing-light signal, since the gain in an optical fiber amplifier changed with number of the lightwave signals wavelength-multiplexing-ized, the problem that stable reception could not be performed arose.

[Translation done.]

MEANS

[Means for Solving the Problem]The purpose of this invention generates an abnormality alarm, when a wavelength gap with a transmission wave length and wavelength which does the minimum loss of a branching filter becomes beyond an acceptable value, and there is in providing wavelength-multiplexing-light transmission equipment which has a function which prevents receiving sensitivity degradation by wavelength gap.
[0014]Other purposes of this invention detect abnormalities of a transmission wave length in a transmission section, and there are in providing wavelength-multiplexing-light transmission equipment which has a function which prevents receiving sensitivity degradation by wavelength gap.
[0015]Other purposes of this invention supervise a transmission wave length and the transmitted wave length characteristic of an optical multiplexer/demultiplexer, and when the wavelength gap is beyond an acceptable value, and a transmission section and a receive section exchange surveillance intelligence mutually, there are in providing wavelength-multiplexing-light transmission equipment which has the function to pinpoint an abnormal spot.
[0016]Other purposes of this invention control a transmission wave length so that a signal to noise ratio in a receive section serves as the maximum, and there are in providing wavelength-multiplexing-light wavelength multiplexing transmission equipment which can always hold a repressed best receive state of an interchannel crosstalk.
[0017]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment which can continue service, even if abnormalities in a transmission wave length occur inside of inservice.
[0018]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment which has a wavelength stabilizing mechanism independent of frequency of abnormal conditions which the wavelength drawing-in range of a semiconductor laser is not restricted to a wavelength interval, and are performed to a semiconductor laser for

wavelength stabilizing.

[0019]Other purposes of this invention are to provide wavelength-multiplexing-light transmission equipment with little wavelength variation to change of outside air temperature.

[0020]Other purposes of this invention are to provide optical repeater which enables stable reception by a receiver without being dependent on the number of lightwave signals which have multiplexed a wavelength-multiplexing-light signal.

[0021]A branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength according to this invention, A wavelength detector which detects a gap with a receiver which receives an outputted ray of this branching filter, and wavelength and a transmission wave length which do the minimum loss of said branching filter, and outputs a signal according to a wavelength gap, Wavelength-multiplexing-light transmission equipment fundamentally characterized by judging that it is unusual when this wavelength gap becomes beyond an acceptable value, and providing a means to report is provided.

[0022]Several semiconductor lasers which differ in an oscillation wavelength according to this invention, and the 1st Monitoring Department which supervises an operating state of the semiconductor laser, A wavelength standard machine used as a standard of a transmission wave length, and the 2nd Monitoring Department which supervises an oscillation wavelength of said semiconductor laser based on this wavelength standard machine, When an oscillation wavelength of said semiconductor laser produces a gap rather than a wavelength standard machine based on surveillance intelligence from the 1st and 2nd Monitoring Department beyond an acceptable value, wavelength-multiplexing-light transmission equipment possessing a means to judge that it is unusual is provided.

[0023]Several semiconductor lasers which differ in an oscillation wavelength according to this invention, and the 1st Monitoring Department which supervises an operating state of the semiconductor laser, A multiplexing machine which multiplexs an outputted ray of a semiconductor laser and obtains a wavelength multiplexing signal light, and a branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength, A receiver which receives an outputted ray of this branching filter, and a wavelength detector which detects a gap with wavelength and a transmission wave length which do the minimum loss of said branching filter, The 1st judgment part judged to be unusual when this wavelength gap becomes beyond an acceptable value, When this 1st judgment part judges that it is unusual, wavelength-multiplexing-light transmission equipment possessing surveillance intelligence from the 1st Monitoring Department and a means to specify any are more unusual between the transmitting side or a receiver based on an output signal from a wavelength detector is provided.

[0024]The 2nd Monitoring Department which supervises an oscillation wavelength of a

semiconductor laser based on a wavelength standard machine used as a standard of a transmission wave length, and this wavelength standard machine according to this invention, The 2nd judgment part judged to be unusual when an oscillation wavelength of a semiconductor laser produces a gap rather than a wavelength standard machine based on surveillance intelligence from said 1st Monitoring Department and the 2nd Monitoring Department beyond an acceptable value, When the 1st judgment part judges that it is unusual, wavelength-multiplexing-light transmission equipment possessing surveillance intelligence from said 1st and 2nd Monitoring Department and a means to specify any are more unusual between the transmitting side or a receiver based on an output signal of a wavelength detector is provided.

[0025]Two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a multiplexing machine which multiplexs an outputted ray from this semiconductor laser, and obtains a wavelength multiplexing signal light, A wavelength detector which detects an oscillation wavelength of a semiconductor laser from an outputted ray of this multiplexing machine, A control circuit which controls wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine based on an output of this wavelength detector, When the 1st judgment part judges that it is unusual, wavelength-multiplexing-light transmission equipment which specifies any are more unusual between the transmitting side or a receiver based on an output signal from the 1st surveillance intelligence and the 1st wavelength detector, and possesses a means to report is provided.

[0026]Two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a multiplexing machine which multiplexs an outputted ray from this semiconductor laser, and obtains a wavelength multiplexing signal light, A branching filter which separates spectrally a wavelength multiplexing signal light transmitted via an optical fiber for every wavelength, Wavelength-multiplexing-light transmission equipment possessing a receiver which receives an outputted ray of this branching filter, a means to detect a signal to noise ratio in this receiver, and a control circuit which controls a transmission wave length so that a detected signal to noise ratio serves as the maximum is provided.

[0027]Two or more semiconductor lasers which have different wavelength according to this invention, and a semiconductor laser of a reserve which has different wavelength from these, A multiplexing machine which multiplexs an outputted ray of a semiconductor laser and obtains a wavelength multiplexing signal light, and an optical fiber which transmits this wavelength multiplexing signal light, A wavelength detector which detects a gap with a branching filter which separates a wavelength multiplexing signal light spectrally for every wavelength, and wavelength which does the minimum loss of this branching filter and wavelength of a semiconductor laser, Wavelength-multiplexing-light transmission equipment possessing a

judgment part judged to be unusual when this wavelength gap becomes beyond an acceptable value, and a switch part which changes a sending signal to a spare semiconductor laser when this judgment part judges that it is unusual is provided.

[0028]Two or more AC signal sources which generate an AC signal with which frequency provided respectively corresponding to two or more semiconductor lasers which have a different oscillation wavelength according to this invention, and a semiconductor laser of these plurality differs, A modulation means which carries out intensity modulation of the outputted ray of a semiconductor laser based on an AC signal from these AC signal sources, respectively, A multiplexing means to multiplex an outputted ray of a semiconductor laser and to obtain a wavelength multiplexing signal light, A photoelectric conversion means which receives a part of wavelength multiplexing signal light from this multiplexing means, and is changed into an electrical signal, A means to extract a frequency component of an AC signal generated from two or more AC signal sources from an output signal of this photoelectric conversion means, respectively, Based on a frequency component extracted by this means, wavelength multiplexing transmission equipment possessing a control means which controls each oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing means is provided.

[0029]According to this invention, apart from the 1st control facility that controls an oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine, to wavelength-multiplexing-light transmission equipment, When more than a predetermined number of the oscillation wavelength control to two or more semiconductor lasers twisted to this 1st control facility is control to a uniform direction, a control section which has the 2nd control facility that controls the transmitted wave length characteristic of a multiplexing machine is provided.

[0030]According to this invention, apart from the 1st control facility that controls an oscillation wavelength of a semiconductor laser on wavelength which does the minimum loss of a multiplexing machine, to wavelength-multiplexing-light transmission equipment, Outside air temperature is detected and a control section which has the 2nd control facility that controls a multiplexing machine to compensate the temperature characteristics of a multiplexing machine based on outside-air-temperature change is provided.

[0031]An optical fiber amplifier which amplifies a wavelength-multiplexing-light signal transmitted from wavelength-multiplexing-light transmission equipment according to this invention, A photoelectric conversion part which receives - part of an output of this optical fiber amplifier, and is changed into an electrical signal, A means to extract a frequency component of an AC signal generated from two or more AC signal sources of wavelength-multiplexing-light transmission equipment from an output signal of this photoelectric conversion part, respectively, Optical repeater possessing two or more detection means which detect power of

each frequency component extracted by this means, and a control means which controls a gain of said optical fiber amplifier based on an output of these detection means is provided.

[Translation done.]

* NOTICES *

OPERATION

[Function]In the wavelength-multiplexing-light transmission equipment concerning this invention, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is supervised, and if the wavelength and the transmission wave length which do the minimum loss of a branching filter are in agreement, receiving sensitivity degradation by an interchannel crosstalk will be suppressed by the minimum. Therefore, if an abnormal signal is generated when the above-mentioned wavelength gap becomes beyond an acceptable value, receiving sensitivity degradation by wavelength gap can be prevented.
[0033]The operating temperature of the semiconductor laser used as a light source in the transmission section in the wavelength-multiplexing-light transmission equipment concerning this invention, If abnormalities are observed by the operating state of a semiconductor laser when in addition to the surveillance of the operating state of inrush current **** output power the oscillation wavelength of each semiconductor laser is supervised using a wavelength standard machine and the oscillation wavelength of a semiconductor laser shifts from a wavelength standard machine, it can be judged that a semiconductor laser is unusual. If there are no abnormalities in the operating state of a semiconductor laser, it can be judged that a wavelength standard machine is unusual. Therefore, it can be judged from all such surveillance intelligence whether the thing with an unusual oscillation wavelength or wavelength standard machine of a semiconductor laser is unusual.
[0034]operating states, such as operating temperature of the semiconductor laser used as a light source in the transmission section in the wavelength-multiplexing-light transmission equipment concerning this invention, and inrush current **** output power, -- supervising -- **** . In a receive section, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is supervised. When a wavelength gap is observed in a receive section, if abnormalities are observed by the

operating state of a semiconductor laser, a transmission section will judge that it is unusual, and it can be judged that they are the abnormalities of a receive section except it. Therefore, pinpointing of an abnormal spot can be performed by judging synthetically from such surveillance intelligence.

[0035]In a transmission section, the oscillation wavelength of each semiconductor laser is supervised using a wavelength standard machine, and the specific accuracy of an abnormal spot improves by adding this surveillance intelligence as a judgment source.

[0036]In the wavelength-multiplexing-light transmission equipment concerning this invention, in a receive section, supervise the signal to noise ratio of an input signal, and the signal to noise ratio of an input signal, Since it is an important indicator which determines receiving sensitivity, the best receive state with few channel question cross talks is realizable by controlling a transmission wave length so that a signal to noise ratio serves as the maximum.

[0037]In the wavelength-multiplexing-light transmission equipment concerning this invention, when abnormalities occur in a transmission wave length the inside of inservice, service is changed to the transmitter of the reserve which has another wavelength. Therefore, service is continuable even if the abnormalities in a transmission wave length occur the inside of inservice.

[0038]In the wavelength-multiplexing-light transmission equipment concerning this invention, the penetration characteristic of the multiplexing machine is used as a wavelength standard. When a multiplexing machine multiplexs, and outputs the light inputted into two or more ON KAPOTO to one output port and an output port is seen from one input port, since only one exists, the wavelength which does the minimum loss, The wavelength drawing-in range of a semiconductor laser is not restricted to a wavelength interval, and is secured to the range covering large frequency.

[0039]In this invention, intensity modulation of the abnormal conditions performed to each semiconductor laser for wavelength stabilizing is carried out. Over a wide frequency range, since it is flat, it does not depend for the intensity modulation efficiency of the usual semiconductor laser on the frequency of the modulating signal applied to a semiconductor laser.

[0040]It is judged as that from which the characteristic of the multiplexing machine which is a wavelength standard shifted, and when more than a predetermined number shifts to the long wavelength or short wavelength side simultaneously among each semiconductor laser by which wavelength control is carried out, alarm etc. are generated or the wavelength penetration characteristic of a multiplexing machine is controlled by this invention. This holds a wavelength standard uniformly and stable wavelength control becomes possible.

[0041]Stable wavelength control becomes possible to change of outside air temperature by controlling a multiplexing machine by this invention to perform outside-air-temperature

detection and to compensate the temperature characteristics of the multiplexing machine accompanying outside-air-temperature change.

[0042]By detecting the power of the lightwave signal which the wavelength-multiplexing-light signal has multiplexed, and on the other hand, controlling the gain of an optical fiber amplifier by optical repeater concerning this invention based on it, mail arrival light power is not based on the number of the lightwave signals to multiplex, but becomes fixed, and the stable reception of it is attained.

[0043]

[Embodiment of the Invention]Hereafter, the example of this invention is described based on a drawing.

[0044]In the wavelength-multiplexing-light transmission equipment according to the 1st example of this invention shown in drawing 1, the transmission section T and the receive section R are combined by the optical fiber OF. The transmission section T is optically combined with two or more semiconductor laser (LD) 10_1 which outputs the laser beam of a different oscillation wavelength, respectively, 10_2, --, 10_N, and these semiconductor lasers, respectively, By transmission signal source 11_1, 11_2, --, sending-signal S_1 from 11_N, S_2, --, S_N. It is constituted by optical modulator 12_1 which modulates a laser beam, respectively, 12_2, --, 12_N and the multiplexing machine 13 which multiplexes the modulated light from an optical modulator.

[0045]The receive section R receives the multiplexing laser beam sent via the optical fiber OF from the transmission section T, It is connected to two or more outputting parts of the branching filter 21 separated spectrally for every wavelength, and this branching filter, respectively, and comprises two or more receiver 22_1 which changes the receiving laser beam of different wavelength into an electrical signal, respectively, 22_2, --, 22_N. It is connected to the output terminal of a receiver, and if the gap of the wavelength detector 23 and wavelength which detects gap deltalambda of a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 exceeds an acceptable value based on the transmitted wave length characteristic of the branching filter 21, the alarm generator 24 which generates alarm is prepared for this receive section R.

[0046]In the wavelength-multiplexing-light transmission equipment of the above-mentioned composition, If the outputted ray of semiconductor laser (LD) 10_1, 10_2, --, oscillation wavelength lambda$_1$ from which 10_N differs, lambda$_2$, --, lambda$_N$ is outputted to optical modulator 12_1, 12_2, --, 12_N, Optical modulator 12_1, 12_2, --, 12_N modulate laser output light according to sending-signal S_1, S_2, --, S_N, respectively. Modulated light is inputted into the

multiplexing machine 13, and wavelength multiplexing is carried out here. The output of the multiplexing machine 13 is transmitted to the receive section R via the optical fiber OF.
[0047]In the receive section R, a wavelength multiplexing signal light is separated spectrally for every wavelength with the branching filter 21, and it is received by receiver 22_1, 22_2, --, 22_N, respectively. A part of receiver 22_1, 22_2, --, signal received by 22_N are inputted into the wavelength detector 23, and gap deltalambda of a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 is detected based on the transmitted wave length characteristic of the branching filter 11. When wavelength gap deltalambda detected with the wavelength detector 20 becomes beyond an acceptable value, the wavelength detector 20 sends out an abnormal signal to the alarm generator 30, and generates alarm.
[0048]Thus, the wavelength multiplexing transmission equipment of this example can prevent receiving sensitivity degradation by wavelength gap by generating alarm, when the wavelength gap with a transmission wave length and the spectral separation characteristic of a branching filter is detected and a wavelength gap becomes beyond an acceptable value.
[0049]The receive section R of wavelength multiplexing transmission equipment according to the 2nd example of this invention is shown in drawing 2. According to this example, it is constituted by receiver 22_1 and -- which receive the optical signal from the branching filter 21, the data reproduction machine 22b by which each of 22_N was connected to the photoelectric converter 22a and the outgoing end of this photoelectric converter 22a, and the receiving level detector 22c. The wavelength detector 23 is selectively connected to a receiver via receiver 22_1, --, the switching circuit 23a and the switching circuit 23a that are connected to the output terminal of each receiving level detector 22c of 22_N. It is constituted by the controller 23c connected to the output terminal of the comparator 23b which measures a received signal level and the reference voltage ref, and this comparator 23b.
[0050]According to the receive section R of the above-mentioned composition, it is separated spectrally for every wavelength with the optical separator 21, and the lightwave signal sent via the optical fiber OF from the transmission section T is inputted into receiver 22_1, --, 22_N, respectively. Spectral separation light is changed into an electrical signal by the photoelectric converter 22a in each receiver. The output of a photoelectric converter dichotomizes, the method of - is inputted into the data reproducing part 22b, and it is reproduced as send data. Another side is inputted into the receiving level detector 22c. The receiving level detector 22c detects the power of received spectral separation light based on an input signal, and outputs the voltage according to the power of received spectral separation light.
[0051]The output voltage of the receiving level detector 22c is inputted into the wavelength

detector 23. By the wavelength detector 23, only one channel is chosen by the switching circuit 23a according to the control signal from the controller 23c, and the voltage signal of the selected channel is compared with the reference voltage ref corresponding to the acceptable value of the wavelength gap in the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and the controller 23c sends out an abnormal signal to the alarm generator 24, when a receiving level detector output becomes below reference voltage. In the alarm generator 24, alarm is generated based on the abnormal signal from the controller 23c.

[0052]By composition shown in drawing 2, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the optical separator 21 can be detected using the transmitted wave length characteristic of the optical separator 21, and abnormalities can be reported.

[0053]The receive section R of wavelength multiplexing transmission equipment according to the 3rd example of this invention is shown in drawing 3. In explanation of this example, identical codes are given to the example and identical parts of drawing 2, and that explanation is omitted.

[0054]The output of the receiving level detector 22a is inputted into the wavelength detector 23, only one channel is chosen by the switching circuit 23a according to the control signal from the controller 23c, and a detect output is measured with a certain programmed voltage by the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and the controller 23c will output a control signal to the branching filter control section 25, if a receiving level becomes smaller than a programmed voltage in the comparator 23b. In the branching filter control section 25, the operating temperature of the branching filter 21 is changed according to the control signal from the controller 23c, and the transmitted wave length characteristic of the branching filter 21 is shifted so that the output of the receiving level detector 22c may serve as the maximum. In this case, the Peltier device is attached to the branching filter 21, and the operating temperature of the branching filter 21 is controlled by this Peltier device.

[0055]The branching filter control section 25 outputs the output voltage according to the variation (shift amount of the transmitted wave length characteristic) of the operating temperature of the branching filter 21 to the controller 23c. In the controller 23c, a wavelength gap is detected from the output voltage from the branching filter control section 25, and when the wavelength gap is beyond an acceptable value, an abnormal signal is outputted to the alarm generator 24.

[0056]Also by composition of this 3rd example, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of an optical separator is detectable using the transmitted wave length characteristic of an optical separator.

[0057]The wavelength-multiplexing-light transmission equipment according to the 4th example of this invention is shown in drawing 4. In this example, identical codes are given to drawing 1 thru/or the example and identical parts of drawing 3, and that explanation is omitted.
[0058]In this example, it is inputted into the wavelength detector 23, only one channel is chosen in the switching circuit 23a, and the output of the receiving level detector 22c of each receiver is measured with a certain programmed voltage by the comparator 23b. The output of the comparator 23b is inputted into the controller 23c, and if a receiving level becomes smaller than a programmed voltage, the controller 23c sends out a wavelength control signal to the wavelength control section 26 via the control signal dedicated line L.
[0059]An oscillation wavelength is controlled by the wavelength control section 26 by changing the operating state (for example, operating temperature) of semiconductor laser 10_1, 10_2, --10_N so that the output of the receiving level detector 22c may serve as the maximum according to a wavelength control signal. Semiconductor laser 10_1, 10_2, --10_N send out the variation of an operating state to the receive section R as a - part of data.
[0060]In the receive section R, since the variation of the operating state of a semiconductor laser is transmitted as some data, the variation of the operating state of a semiconductor laser is detected not with the receiving level detector 22c but with the data reproduction machine 22b. The variation detected with the data reproduction machine 22b is sent out to the controller 23c, and a wavelength gap is detected. That is, in the controller 23c, a wavelength gap of the channel is detected from the variation (variation of an outputted ray level) of the operating state of a semiconductor laser, and if this is beyond an acceptable value, the controller 23c will output an abnormal signal to the alarm generator 24.
[0061]In this case, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected from change of the operating state of a semiconductor laser.
[0062]Although detection of the receiving level was performed in the above-mentioned example by detecting the optical power level after a laser beam penetrates the branching filter 21, Intensity modulation of the outputted ray of a semiconductor laser is carried out with the AC signal which has different frequency for every semiconductor laser, and it may carry out by extracting each of that ingredient.
[0063]In the above-mentioned example, although the wavelength control signal was sent out via the control signal dedicated line, it may send out via the communication line which counters.
[0064]With reference to drawing 5, the receive section of the wavelength-multiplexing-light transmission equipment of the 5th example of this invention is explained.
[0065]In this example, the wavelength multiplexing signal light transmitted via the optical fiber

OF is amplified with the light amplifier 31. - part branching of the outputted ray of the light amplifier 31 is carried out with the coupler 32, it is inputted into the light power detector 33, and the remainder is inputted into the branching filter 21. In the light power detector 334, the output light power of the light amplifier 31 is detected, and the voltage according to the detected light power is outputted to the gain control machine 34. The gain control machine 34 controls the gain of the light amplifier 31 so that the output light power of the light amplifier 31 becomes fixed. The branching filter 21 separates a wavelength multiplexing signal light spectrally for every wavelength, and inputs it into receiver 22_1, --, 22_N respectively. In each receiver, a reception beam is changed into an electrical signal and a receiving level is detected. The wavelength detector 23 detects the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 from the detected receiving level, and when this gap is beyond an acceptable value, it outputs an abnormal signal to the alarm generator 24.
[0066]In this example, since the input light power to the branching filter 21 is kept constant, change of the optical power level after spectral separation corresponds to the increase in a loss with the branching filter 21 by wavelength gap. Therefore, even if change of the light power in a transmission line arises, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the branching filter 21 is stably detectable.
[0067]Control of a gain is performed by controlling the output power of the pump light of the light amplifier 31. A variable optical attenuator may be formed in the output of the light amplifier 31, and the magnitude of attenuation may be controlled.
[0068]****** is explained to the 6th example of this invention with reference to drawing 6.
[0069]Semiconductor laser 10_1, --, AC signal source 14_1 provided respectively corresponding to 10_N, --, the AC signal of frequency (f_1, --, f_N) with which 14_N differs are generated. These AC signals are superimposed by the output of bias circuit 16_1, --, 16_N by adding machine 15_1, --, 15_N, and are poured into semiconductor laser 10_1, --, 10_N. Thereby, according to AC signal source 14_1, --, the AC signal that 14_N generates, intensity modulation of the outputted ray of semiconductor laser 10_1, --, 10_N is carried out. Semiconductor laser 10_1, --, after being multiplexed with the multiplexing machine 21, the outputted ray of 10_N branches in part with the coupler 27, and the wavelength Monitoring Department 40 is presented with it after penetrating the wavelength standard machine 28. An optical resonator etc. are used as the wavelength standard machine 28 here.
[0070]At the wavelength Monitoring Department 40, the output of the photoelectric converter 41, It is inputted into band pass filter 43_1 and -- which have center frequency in the same

frequency as AC signal source 14_1, --, the AC signal that 14_N generates, and 43_N, after being amplified by the amplifier 42 and doing N branching of further. Synchronous detection of the output of these band pass filter 43_1, --, 43_N is carried out by synchronous detector 44_1, --, 44_N.

[0071]Synchronous detector 44_1, --, after the output of 44_N removes low pass filter part 45_1, --, a high frequency component unnecessary at 45_N, it is inputted into the microprocessor 46. In the microprocessor 46, based on the synchronous detection output value inputted via a low pass filter, semiconductor laser 10_1, --, the wavelength gap with 10_N and the wavelength which does the minimum loss of the multiplexing machine 21 are detected, and the voltage according to the wavelength gap is outputted to the abnormality judgment part 47. The abnormality judgment part 47 outputs an abnormal signal to the alarm generator 48, when a wavelength gap becomes beyond an acceptable value. In the alarm generator 48, if an abnormal signal is received, alarm will be generated, and it notifies outside.

[0072]In this example, since alarm is emitted when a wavelength gap of a transmission wave length is detected and the wavelength gap becomes beyond an acceptable value, receiving sensitivity degradation by wavelength gap can be prevented.

[0073]Although the wavelength standard machine was used in the above-mentioned example, the transmitted wave length characteristic of a multiplexing machine may be used as a wavelength standard machine.

[0074]The transmission section T of wavelength multiplexing transmission equipment which followed the 7th example of this invention with reference to drawing 7 is explained. In this example, identical codes are given to the example and identical parts of drawing 6, and the explanation is omitted.

[0075]It is multiplexed in the outputted ray of semiconductor laser 10_1, --, 10_N with the multiplexing machine 13. - part of the output of the multiplexing machine 13 is inputted into the wavelength Monitoring Department 40 with the coupler 27. At the wavelength Monitoring Department 40, each semiconductor laser 10_1, --, the wavelength gap with the oscillation wavelength of 10_N and the wavelength which does the minimum loss of the multiplexing machine 13 are detected, and the voltage corresponding to the wavelength gap is outputted to the abnormality judgment part 47.

[0076]Operating state Monitoring Department 17_1, ..., 17_N supervise the operating state of the operating temperature, the inrush current, and output power of each semiconductor laser, and output the information to the abnormality judgment part 47. From the surveillance intelligence from the operating state Monitoring Department, and the information about the

wavelength gap from the wavelength Monitoring Department, the abnormality judgment part 47 judges a gap of a transmission wave length or a gap of the wavelength characteristic of a multiplexing machine, and when the gap is beyond an acceptable value, it outputs an abnormal signal.
[0077]In this example, since the information about the operating state of a semiconductor laser is also used for unusual judgment, it can be presumed whether the oscillation wavelength of a semiconductor laser is unusual, and whether the wavelength characteristic of the multiplexing machine used as a wavelength standard is unusual.
[0078]The wavelength-multiplexing-light transmission equipment of the 8th example of this invention is explained to drawing 8.
[0079]In this example, each semiconductor laser 10_1, --, operating state Monitoring Department in which 10_N supervises operating states, such as that operating-temperature, actuating current, and output power, 17_1, --, 17_N are provided. Each operating state Monitoring Department outputs the supervisory signal according to the operating temperature, actuating current, and output power of the semiconductor laser to the abnormality judgment part 47.
[0080]It is multiplexed with the multiplexing machine 13 and the outputted ray of semiconductor laser 10_1, --, 10_N is transmitted via the optical fiber OF. It is separated spectrally for every wavelength with the branching filter 21, and the wavelength multiplexing signal light transmitted via the optical fiber OF is received by optical receiver 22_1, --, 22_N. The wavelength detector 23 sends out an abnormal signal to the abnormality judgment part 47 via the control signal dedicated line L, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected based on the receiving level of each optical receiver and a wavelength gap becomes beyond an acceptable value. The abnormality judgment part 47 judges the abnormal signal from the wavelength detector 23, operating state Monitoring Department 17_1, being --, being a thing with a transmission wave length unusual based on the surveillance intelligence from 17_N, and whether a branching filter is unusual. It not only detects a wavelength gap, but in this example, since it judges any are more unusual between the transmission section T and the receive section R, it can pinpoint an abnormal spot. In this example, although the control signal dedicated line L was used for transfer of the abnormal signal from a wavelength detector to the abnormality judgment part 47, the communication line which counters may be used.
[0081]The wavelength-multiplexing-light transmission equipment of the 9th example of this invention is explained to drawing 9. In this example, identical codes are given to the example and identical parts of drawing 8, and that explanation is omitted.

[0082]It is multiplexed in the outputted ray from semiconductor laser 10_1, --, 10_N with the multiplexing machine 13. - part of the outputted ray from the multiplexing machine 13 branches with the coupler 32, and is inputted into the wavelength Monitoring Department 40. At the wavelength Monitoring Department 40, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of the multiplexing machine 13 is supervised by making the transmitted wave length characteristic of the multiplexing machine 13 into a wavelength standard, and the output signal according to this wavelength gap is outputted to the abnormality judgment part 47. In the abnormality judgment part 47, if the abnormal signal from the wavelength detector 23 is received, this abnormal signal, operating state Monitoring Department 17_1, --, a thing with a transmission section unusual based on the supervisory signal from 17_N and the supervisory signal from the wavelength Monitoring Department 41, and a receive section will judge whether it is unusual.

[0083]In this example, since the surveillance intelligence of the transmission wave length is also used as a decision criterion, precision improvement of abnormal spot specification can be planned.

[0084]The wavelength-multiplexing-light transmission equipment of the 10th example of this invention is explained to drawing 10. In this example, identical codes are given to drawing 8, and the example and identical parts of drawing 9, and that explanation is omitted.

[0085]Semiconductor laser 10_1, --, AC signal source 14_1 provided respectively corresponding to 10_N, --, the AC signal of frequency (f_l, f_2, --, f_N) with which 14_N differs are generated. These AC signals are superimposed by the output of bias circuit 16_1, --, 16_N by adding machine 15_1, --, 15_N, and are poured into semiconductor laser 10_1, --, 10_N. Thereby, according to AC signal source 14_1, --, the AC signal that 14_N generates, intensity modulation of the outputted ray of semiconductor laser 10_1, --, 10_N is carried out.

[0086]- part branching is carried out with the coupler 32, and the outputted ray of 10_N is inputted into the photoelectric converter 41, after being multiplexed with the multiplexing machine 13, semiconductor laser 10_1, --,. After the output of the photoelectric converter 41 is amplified by the amplifier 42 and N branching of it is done further, it is inputted into band pass filter 43_1 and -- which have center frequency in the same frequency as AC signal source 14_1, --, the AC signal that 14_N generates, and 43_N. Synchronous detection of the output of these band pass filters is carried out by synchronous detector 44_1, --, 44_N. After the output of a synchronous detector removes low pass filter 45_1, --, a high frequency component

unnecessary at 45 $_N$, it is inputted into the microprocessor 46. In a microprocessor part, based on the synchronous detection output value inputted via a low pass filter, so that the oscillation wavelength of 10 $_N$ may turn into semiconductor laser 10 $_1$, --, wavelength that does the minimum loss of the multiplexing machine 13, The temperature of semiconductor laser 10 $_1$, --, 10 $_N$ is controlled. The wavelength stabilizing of a semiconductor laser is realizable by this control.

[0087]Each semiconductor laser 10 $_1$, --, the operating state of the operating temperature, the inrush current, and output power of 10 $_N$ are supervised by operating state Monitoring Department 17 $_1$, --, 17 $_N$.

[0088]On the other hand, it is separated spectrally for every wavelength with the branching filter 21, and the wavelength multiplexing signal light transmitted via the optical fiber OF is received by optical receiver 22 $_1$, --, 22 $_N$. The wavelength detector 23 sends out an abnormal signal to the abnormality judgment part 47 via the control signal dedicated line L, when the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter is detected based on the receiving level of each optical receiver and this wavelength gap becomes beyond an acceptable value. The abnormality judgment part 47 judges the abnormal signal from the wavelength detector 23, operating state Monitoring Department 17 $_1$, being --, being a thing with a transmission wave length unusual based on the surveillance intelligence from 17 $_N$, and whether a branching filter is unusual.

[0089]Since each transmission wave length is stabilized by the wavelength which does the minimum loss of a multiplexing machine, what is necessary will be to detect only the wavelength gap with the wavelength characteristic of a multiplexing machine, and the wavelength characteristic of a branching filter in a wavelength detector in this example. Therefore, simplification of a wavelength monitoring function can be attained.

[0090]Furthermore based on the surveillance intelligence from operating state Monitoring Department 17 $_1$, --, 17 $_N$, the abnormalities of each semiconductor laser 10 $_1$, --, 10 $_N$ are detectable.

[0091]The wavelength-multiplexing-light transmission equipment of the 11th example of this invention is explained to drawing 11.

[0092]It is multiplexed with the multiplexing machine 13 and the outputted ray from semiconductor laser 10 $_1$, --, 10 $_N$ turns into a wavelength multiplexing signal light. The wavelength multiplexing signal light transmitted via the optical fiber OF is respectively received by optical receiver 22 $_1$, --, 22 $_N$, after being separated spectrally for every wavelength with the

branching filter 21. The signal-to-noise-ratio test section 51 is presented with - part of the output of each optical receiver. In the signal-to-noise-ratio test section 51, the signal to noise ratio of an input signal is measured, and a feedback control signal is sent out to a transmission section via the control signal dedicated line L so that this ratio may serve as the maximum. The wavelength control section 52 controls the transmission wave length of each semiconductor laser according to this control signal. Since according to this example a transmission wave length is controlled so that the signal to noise ratio in each optical receiver serves as the maximum, the signal transmission in the state of becoming the minimum of the cross talk from other channels becomes possible. Although the feedback control signal was sent out via the control signal dedicated line in this example, it may send out via the communication line which counters. The example of the signal-to-noise-ratio system of measurement is shown in drawing 12. According to this, the lightwave signal of each wavelength (lambdai, i= 1, 2, --, N) separated spectrally with the branching filter is changed into an electrical signal with the photoelectric converter 61i (i= 1, --, N), and after being amplified with the amplifier 62i, it trifurcates. The branched signal is inputted into the 1st discrimination decision circuit 63i, 2nd discrimination decision circuit 64i, and clock extraction circuit 65i, respectively. A clock extraction circuit carries out the ejection of the clock component of a transmission signal, and supplies a clock signal to the 1st and 2nd discrimination decision circuits 63i and 64i. In the 1st discrimination decision circuit 63i, optimization of discernment RE ** RU is made.
The transmitted data is reproduced.
On the other hand, in the 2nd discrimination decision circuit 64i, a discrimination level is changed based on the control signal from the microprocessor 67i, and data is reproduced based on the discrimination level. The exclusive OR circuit 66i takes the exclusive OR of the data reproduced in the 1st and 2nd discrimination decision circuits 63i and 64i. The microprocessor 67i calculates Q value based on the output of the exclusive OR circuit 66i, and outputs the voltage corresponding to the calculated Q value to the signal-to-noise-ratio test section 51. In the signal-to-noise-ratio test section 51, the signal to noise ratio of a sending signal is calculated based on a formula (1) from the calculated Q value.
[0093]Q=20log (S/N) -- - (1)
Measurement of the signal to noise ratio of a sending signal is attained with constituting in this way.
[0094]The wavelength-multiplexing-light transmission equipment of the 13th example concerning this invention is explained to drawing 13.
[0095]According to this example, each sending-signal S_l, S_2, --, S_N are inputted into optical modulator 12_1, --, 12_N via switching circuit 18_1, --, 18_N. It has semiconductor laser 10_1, --, oscillation wavelength [from which 10_N differs respectively] λ_1, λ_2, ..., and

lambda$_N$, and intensity modulation of the outputted ray is carried out by optical modulator 12 $_1$, 12 $_2$, --, 12 $_N$, and it is multiplexed with the multiplexing machine 13. Spare semiconductor laser 10$_{N+1}$ has different oscillation wavelength lambda$_{N+l}$ from the above-mentioned semiconductor laser, and it is multiplexed with the multiplexing machine 13 like the above-mentioned semiconductor laser via optical modulator 12$_{N+1}$. It is transmitted via the optical fiber OF, and is separated spectrally for every wavelength with the branching filter 21, and the output of the multiplexing machine 13 is received, respectively by optical receiver 22 $_1$, --, 22 $_N$, and 22$_{N+1}$.

[0096]The wavelength detector 23 detects optical receiver 22 $_1$, --, the wavelength gap with a transmission wave length and the wavelength which does the minimum loss of a branching filter based on each receiving level of 22 $_N$ and 22$_{N+1}$, When this wavelength gap becomes beyond an acceptable value, a switch control section 50 HE abnormal signal is sent out via the control signal dedicated line L.

[0097]In the switch control section 50, reception of this abnormal signal will output a control signal to BE ** which changes the sending signal of the channel judged to be unusual to spare wavelength lambda$_{N+1}$, switch 18 $_1$, --, 18 $_N$ and the switch 19.

[0098]According to this example, even if the abnormalities in wavelength occur the inside of inservice, recovery of a system can be aimed at by changing the sending signal of the channel which abnormalities generated to spare wavelength, without interrupting service. In this example, although the abnormal signal was sent out via the control signal dedicated line, it may send out via the communication line which counters. Drawing 14 is a figure showing the composition of the wavelength-multiplexing-light transmission equipment concerning the 14th example of this invention. In the figure, semiconductor laser (LD) 111 $_1$, l11 $_2$, --, AC signal source 112 $_1$ provided respectively corresponding to 111 $_N$, 112 $_2$, --, 112 $_N$, The AC signal of different frequency (f_l, f_2, --, f_N) is generated. Here, frequency f_l, f_2, --, and f_N are set as send data S_1, S_2, --, the low frequency region of S_N out of band. These AC signals are superimposed by the output of bias circuit 114 $_1$, 114 $_2$, --, 114 $_N$ by adding machine 113 $_1$, 113 $_2$, --, 113 $_N$, By semiconductor laser 111 $_1$, l11 $_2$, --, this that is poured into 111 $_N$. According to AC signal source 112 $_1$, 112 $_2$, --, the AC signal that 112 $_N$ generates, intensity modulation of the outputted ray of semiconductor laser 111 $_1$, l11 $_2$, --, 111 $_N$ is carried out.

[0099]The outputted ray of semiconductor laser 111 $_1$, l11 $_2$, --, 111 $_N$, In external modulator

130_1, 130_2, --, 130_N, send data S_1, S_2, --, after S_N becomes irregular, respectively, wavelength multiplexing is carried out with the multiplexing machine 110. The multiplexing machine using the concave grating as the multiplexing machine 110 is used. The wavelength-multiplexing-light signal outputted from the multiplexing machine 110 dichotomizes with the optical coupler 125, after the method of - is amplified by the optical fiber amplifier 140, it is sent out to the optical fiber 100 for transmission, and another side is supplied to the photoelectric converter 125.

[0100]The output of the photoelectric converter 125 is amplified by the amplifier 109, and n branching further After being carried out, AC signal source 112_1, 112_2, --, band pass filter (BPF) 116_1 that has center frequency in the same frequency as the AC signal which 112_N generates, 116_2, --, 116_N are supplied. Namely, in band pass filter 116_1, 116_2, --, 116_N. The ingredient of AC signal source 112_1, 112_2, --, same frequency [as the AC signal which 112_N generates] f_l, f_2, --, f_N is extracted among the outputs of the photoelectric converter 125. The output of these band pass filter 116_1, 116_2, --, 116_N, It can take advantaging by synchronous detector 115_1, 115_2, --, 115_N, respectively with AC signal source 112_1, 112_2, --, the AC signal outputted from 112_N, It is inputted into the microcomputer 20 after an unnecessary high frequency component is removed by ROHASU filter (LPF) 117_1, 117_2, -- 117_N as for the output of 115_N, synchronous detector 115_1 by which synchronous detection is carried out, 115_2, --,.

[0101]Based on the synchronous detection output value inputted via low pass filter 117_1, 117_2, --117_N, the MAI clo computer 20, The temperature of semiconductor laser 111_1, $l11_2$, --, 111_N is controlled so that the oscillation wavelength of 111_N turns into semiconductor laser 111_1, $l11_2$, --, wavelength that does the minimum loss of the multiplexing machine 110. Wavelength stabilizing of semiconductor laser 111_1, $l11_2$, --, 111_N is realized by this control.

[0102]That is, it is judged whether the synchronous detection output which the synchronous detection output was incorporated and was incorporated as shown in the flow chart of drawing 15 is the maximum. In this judgment, if the incorporated synchronous detection output value is not the maximum, temperature control of semiconductor laser LD will be performed so that it may become the maximum. If it is the maximum, a synchronous detection output will be incorporated again.

[0103]The temperature control system of semiconductor laser LD is shown in drawing 16. According to this, Peltier device PE is attached to semiconductor laser LD as a heating

element, this Peltier device PE drives with the driver 121 controlled by the microcomputer 120, and temperature control is carried out. The temperature of semiconductor laser LD is measured by the thermo sensitive register TH attached to Peltier device PE. Measurement temperature is sent to the microcomputer 120 and a semiconductor laser is monitored for temperature.

[0104]The penetration characteristic and the synchronous detection output of the multiplexing machine 110 are shown in drawing 17. If the temperature of semiconductor laser 111_1, $l11_2$, --, 111_N is controlled by the MAI clo computer 120 clearly from the figure so that a synchronous detection output serves as the maximum, semiconductor laser 111_1, $l11_2$, --, oscillation wavelength $lambda_1$ of 111_N, $lambda_2$, -- and . it turns out to be that $lambda_N$ is stabilized by the wavelength which does the minimum loss of the multiplexing machine 110 -- again, As for the transmission loss property over wavelength when each ON KAPOTO of the multiplexing machine 110 to an output port is seen from drawing 17, it turns out that the wavelength which does the minimum loss **** only - **. Therefore, even if it changes to the field of the wavelength of semiconductor laser 111_1, $l11_2$, --, wavelength $lambda_1$ of 111_N, $lambda_2$, --, the semiconductor laser in which $lambda_N$ adjoins, It can draw in desired wavelength semiconductor laser 111_1, $l11_2$, --, by controlling the temperature of 111_N so that a synchronous detection output may serve as the maximum. That is, it is not dependent on a wavelength interval and the cotton intermediary reservation of the wavelength drawing-in range of semiconductor laser 111_1, $l11_2$, --, 111_N is carried out in a wide frequency range.

[0105]Thus, since the wavelength drawing-in range is not dependent on a wavelength interval and is secured over the wide range, semiconductor laser 111_1, $l11_2$, --, the wavelength stabilizing control more stable to 111_N of the wavelength stabilizer of this example are attained.

[0106]In this invention, control which was stabilized regardless of modulation frequency for wavelength stabilizing unlike the frequency modulation used with the conventional wavelength-multiplexing-light transmission equipment since semiconductor laser 111_1, $l11_2$, --, the abnormal conditions performed to 111_N were intensity modulation can be performed.

[0107]Although temperature was controlled in the above-mentioned example for the wavelength control of semiconductor laser 111_1, $l11_2$, --, 111_N, wavelength control may be performed by semiconductor laser 111_1, $l11_2$, --, controlling the inrush current to 111_N.

[0108]When using multielectrode-arrays laser as a semiconductor laser, it may be made to perform wavelength control and output-power control by controlling the inrush current to a

semiconductor laser simultaneously.

[0109]Drawing 18 shows the composition of the transmission section of the wavelength-multiplexing-light transmission equipment concerning the 15th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0110]In n branching, the output of the amplifier 109 in this example After being carried out, AC signal source 112_1, 112_2, --, frequency f_l of the AC signal which 112_N generates, f_2, --, band pass filter 116_1 with the same center frequency as f_N, 116_2, --, 116_N are supplied. Namely, in band pass filter 116_1, 116_2, --, 116_N. Among the outputs of the photoelectric converter 125, AC signal source 112_1, 112_2, --, the ingredient of the same frequency as the AC signal which 112_N generates, That is, the frequency component of semiconductor laser 111_1, $l11_2$, -- and the modulation components of the intensity modulation performed to 111_N, i.e., f_l, f_2, --, f_N is extracted, respectively for wavelength stabilizing. The output of these band pass filter 116_1, 116_2, --, 116_N is detected by wave detector 150_1, 150_2, --, 150_N, respectively. In this case, it has wave detector 150_1, 150_2, --, the characteristic as the synchronous detection output shown in drawing 17 that the detection output of 150_N is the same. . Therefore, the microcomputer 120 is inputted via low pass filter 117_1, 117_2, --, 117_N. Based on the output of wave detector 150_1, 150_2, --, 150_N, According to the flow chart shown in drawing 15, the temperature of semiconductor laser 111_1, $l11_2$, --, 111_N is controlled to become semiconductor laser 111_1, $l11_2$, --, the wavelength that does the minimum loss of the multiplexing machine 110 about the wavelength of 111_N. Thereby, the wavelength stabilizing of semiconductor laser 111_1, $l11_2$, --, 111_N is realizable like the 14th example.

[0111]Drawing 19 shows the composition of the wavelength-multiplexing-light transmission equipment concerning the 16th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0112]in this example -- all the semiconductor laser 111_1, $l11_2$, --, 111_N, and ** -- more than a predetermined number among them. For example, when the microcomputer 120 judges more than a moiety that it makes a uniform direction (short wavelength either a long wavelength side or the side the direction of the method of -) consider wavelength as a shift simultaneously, The wavelength of semiconductor laser 111_1, $l11_2$, --, 111_N did not shift, but it considers that the gap of the abnormalities of the multiplexing machine 110, i.e., the transmitted wave length characteristic, arose, and the microcomputer 120 drives the alarm

generator 135 and generates alarm. In such a case, the microcomputer 120 outputs a control signal so that the transmitted wave length characteristic of the multiplexing machine 110 may be adjusted. Here, adjustment of the transmitted wave length characteristic of the multiplexing machine 110 is performed by controlling temperature.

[0113]That is, as shown in the flow chart of drawing 20, a synchronous detection output is incorporated and it is judged whether the incorporated synchronous detection output is the maximum. If this judgment is YES, it will return to the flow of synchronous detection output incorporation, and if it is NO, it will be judged whether the number of the semiconductor lasers which should be carried out a wavelength shift to a uniform direction is more than a predetermined number (N pieces). If this judgment is YES, alarm will be emitted, and if it is NO, temperature control of semiconductor laser LD will be performed.

[0114]By this example, the microcomputer 120 as mentioned above for the wavelength stabilizing of semiconductor laser 111_1, $I11_2$, --, 111_N, Via low pass filter 117_1, 117_2, --117_N. Semiconductor laser 111_1, $I11_2$, --, 111_N are controlled so that the oscillation wavelength of 111_N turns into a semiconductor laser, 111_1, $I11_2$, --, wavelength that does the minimum loss of the multiplexing machine 110 based on the synchronous detection output value inputted, Semiconductor laser 111_1, $I11_2$, --, when more than the predetermined number of the oscillation wavelength control to 111_N needs control of a uniform direction, the transmitted wave length characteristic of the multiplexing machine 110 is controlled.

[0115]thus, the thing for which it has the same effect as the 14th example according to this example -- in addition, since the transmitted wave length characteristic of the multiplexing machine 10 can always be kept constant, the effect that more stable wavelength control becomes possible is acquired.

[0116]Drawing 21 is a figure showing the composition of the wavelength-multiplexing-light transmission equipment concerning the 17th example of this invention. In this example, identical codes are attached about the example and identical parts of drawing 14, and that explanation is omitted.

[0117]In this example, in addition to the composition of the example of drawing 14, the outside-air-temperature sensing device 160 is formed, and the output signal of this outside-air-temperature sensing device 160 is inputted into the microcomputer 120. Here, the temperature characteristics of the multiplexing machine 110 are known beforehand, and the microcomputer 120 controls the oscillation wavelength of the multiplexing machine 110 to compensate the temperature characteristics of the multiplexing machine 110 based on the signal from the outside-air-temperature sensing device 160.

[0118]That is, as shown in the flow chart of drawing 22, the microcomputer 120 incorporates the outdoor air temperature of the outdoor-air-temperature detector 160, and this temperature

judges whether it is in a preset value. If it is outside a preset value (i.e., if it is NO), after performing temperature compensating control to the multiplexing machine 110, temperature control of a semiconductor laser will be performed. If it is YES, temperature control of a semiconductor laser will be performed. In the wavelength control of a semiconductor laser, the microcomputer 120 incorporates a synchronous detection output and judges whether the incorporated synchronous detection output is the maximum. In this judgment, if the incorporated synchronous detection output value is not the maximum, the microcomputer 120 will carry out temperature control of semiconductor laser LD via the temperature control system shown in drawing 16, and if it is the maximum, a synchronous detection output will be incorporated again. In the temperature control of a semiconductor laser, for the wavelength stabilizing of semiconductor laser 111_1, $l11_2$, --, 111_N, Via low pass filter 117_1, 117_2, --117_N. Semiconductor laser 111_1, $l11_2$, --, 111_N are controlled so that the oscillation wavelength of 111_N turns into half-**** laser 111_1, $l11_2$, --, wavelength that does the minimum loss of the multiplexing machine 110 based on the synchronous detection output value inputted.

[0119]therefore, the thing for which it has the same effect as the 14th example also in this example -- in addition, the effect that stable wavelength control becomes possible to outside-air-temperature change is acquired.

[0120]Drawing 23 shows the composition of the optical repeater combined with wavelength-multiplexing-light transmission equipment as the 18th example of this invention.

[0121]The wavelength multiplexing signal transmitted by the optical fiber 100 from the wavelength-multiplexing-light transmission equipment explained in the 14th - the 17th example, The optical fiber amplifier 141 which is amplified by the optical fiber amplifier 141 and with which transmission is again presented by the optical fiber 100 comprises WDM couplers 126, the erbium doped fiber 110, and the light source 180,181 for excitation.

[0122]The outputted ray (wavelength-multiplexing-light signal) from the optical fiber amplifier 141 dichotomizes with the optical coupler 127, and - part is supplied to the photoelectric converter 125, and is changed into an electrical signal. The output of the photoelectric converter 125 is amplified with the amplifier 109, and after n branching of is done, it is supplied to band pass filter 116_1, 116_2, --, 116_N. The passing center frequency of band pass filter 116_1, 116_2, --, 116_N, In wavelength-multiplexing-light transmission equipment, semiconductor laser 111_1, $l11_2$, --, frequency f_l of the AC signal used in order to stabilize the wavelength of 111_N, f_2, --, f_N are supported, respectively. The output of band bus filter 116_1, 116_2, --, 116_N is detected by wave detector 150_1, 150_2, --, 150_N, respectively. The controller 170 controls the gain of the optical FUAIPA amplifier 141 wave detector 150_1, 150_2, --, by controlling the

output power of the light source 180,181 for excitation based on the output of 150 $_N$.

[0123]That is, as shown in the flow chart of drawing 24, the controller 170 judges [wave detector 150 $_1$, 150 $_2$, --,] whether each wavelength is in a preset value by incorporating a detection output from 150 $_N$. If output power is in a preset value, the gain of the optical fiber amplifier 141 will be controlled.

[0124]Thus, since according to this example it is not based on the number of the lightwave signals multiplexed as a wavelength-multiplexing-light signal but the gain of the lightwave signal of each wavelength is made to regularity, in a receiving set, mail arrival power becomes always fixed, and stable reception is attained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 1st example of this invention.
[Drawing 2]The block diagram of the receive section of wavelength-multiplexing-light transmission equipment according to the 2nd example of this invention.
[Drawing 3]The block diagram of the receive section of wavelength-multiplexing-light transmission equipment according to the 3rd example of this invention.
[Drawing 4]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 4th example of this invention.
[Drawing 5]The block diagram of the receive section of wavelength-multiplexing-light transmission equipment according to the 5th example of this invention.
[Drawing 6]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 6th example of this invention.
[Drawing 7]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 7th example of this invention.
[Drawing 8]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 8th example of this invention.
[Drawing 9]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 9th example of this invention.
[Drawing 10]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 10th example of this invention.
[Drawing 11]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 11th example of this invention.
[Drawing 12]The block diagram of a signal-to-noise-ratio system of measurement used for the wavelength-multiplexing-light transmission equipment according to the 12th example of this

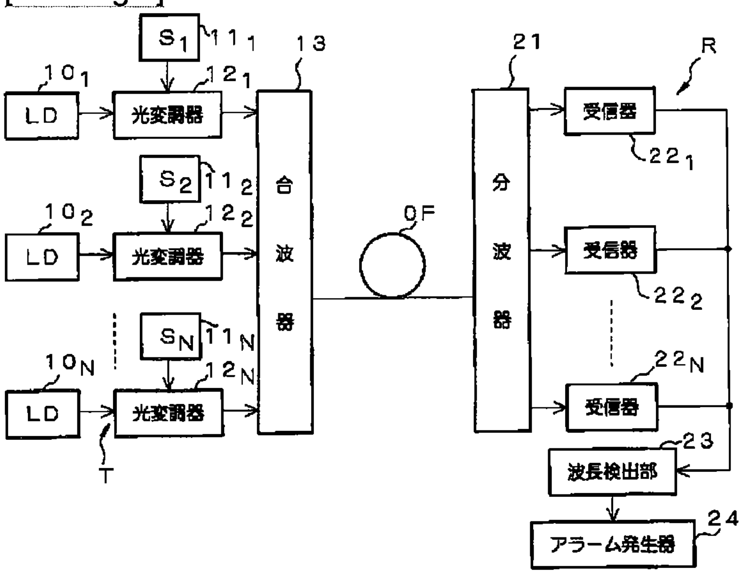
invention.
[Drawing 13]The block diagram of the wavelength-multiplexing-light transmission equipment according to the 13th example of this invention.
[Drawing 14]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 14th example of this invention.
[Drawing 15]The flow chart figure showing LD temperature control of the transmission section of the example.
[Drawing 16]The block diagram of the LD temperature control system of the transmission section of the figure.
[Drawing 17]The figure showing the penetration characteristic and the synchronous detection output of a multiplexing machine in the example.
[Drawing 18]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 15th example of this invention.
[Drawing 19]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 16th example of this invention.
[Drawing 20]The flow chart figure showing LD temperature control of the transmission section of the example.
[Drawing 21]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 17th example of this invention.
[Drawing 22]The flow chart figure showing LD temperature control of the transmission section of the example.
[Drawing 23]The block diagram of the transmission section of wavelength-multiplexing-light transmission equipment according to the 18th example of this invention.
[Drawing 24]The flow chart figure for explaining the gain control of the optical FUAIPA amplifier of the example.
[Description of Notations]
10_1 - 10_N -- Semiconductor laser
11_1 - 11_N -- AC signal source
12_N[12_1 -] -- modulator 3-1,3-2, --, 3-n: Adding machine
13 -- Multiplexing machine
21 -- Branching filter
22_1 - 22_N -- Receiver
22a -- Photoelectric converter
22b -- Data reproduction machine
22c -- Receiving level detector
23 -- Wavelength detector

23a -- Switching circuit
23b -- Comparator
23c -- Controller
24 -- Alarm generator
25 -- Branching filter controller
26 -- Wavelength control machine
40 -- Wavelength Monitoring Department
47 -- Abnormality judgment part
48 -- Alarm generator
110 -- Multiplexing machine
111_1 - 111_N -- Semiconductor laser
112_1 - 112_N -- AC power supply
113_1 - 113_N -- Adding machine
114_1 - 114_N -- Bias circuit
115_1 - 115_N -- Synchronous detector
116_1 - 116_N -- Band pass filter
117_1 - 117_N -- Low pass filter
120 -- Microcomputer
125 -- Photoelectric converter
130_1 - 130_N -- External modulator

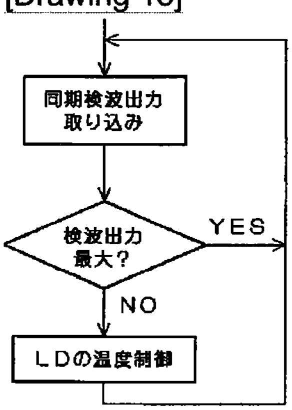
[Translation done.]

DRAWINGS

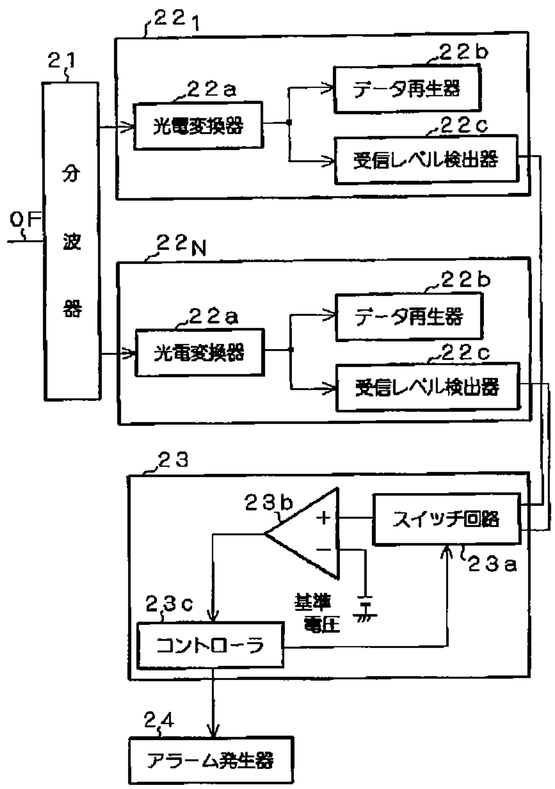
[Drawing 1]



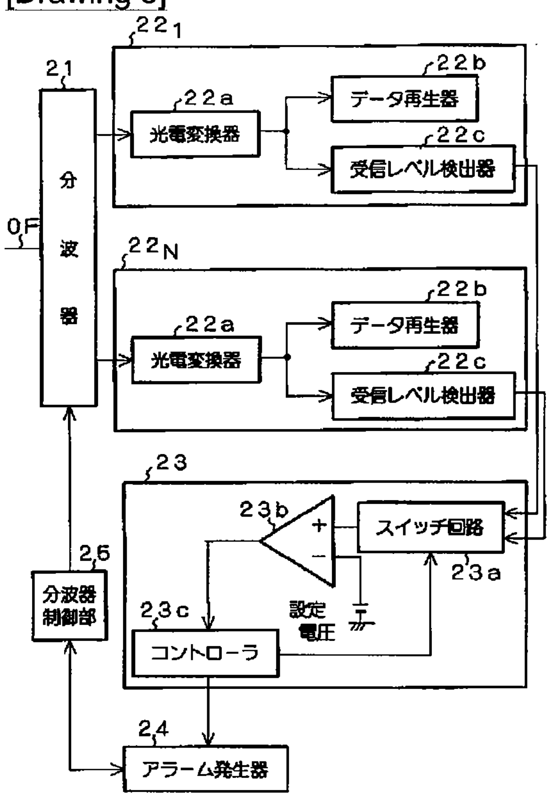
[Drawing 15]



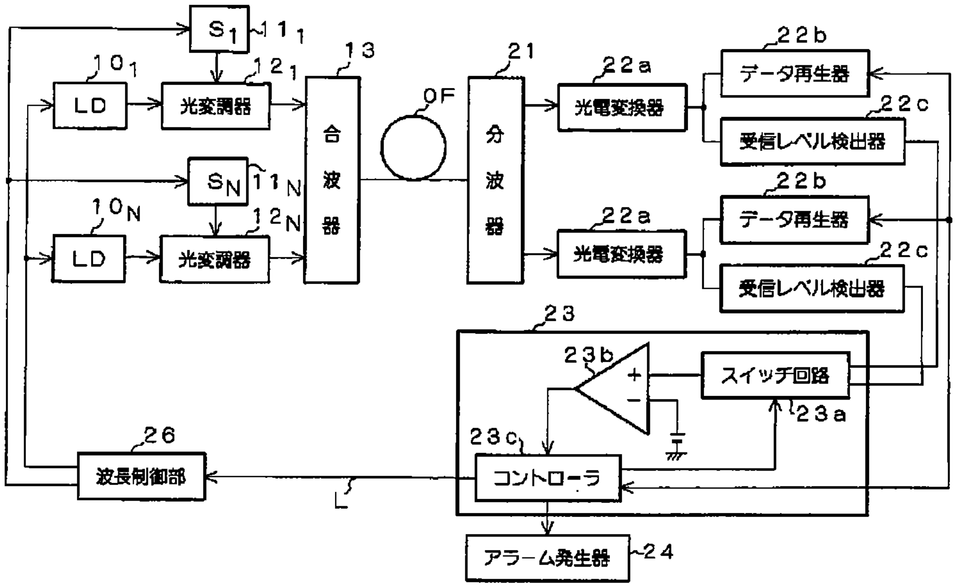
[Drawing 2]



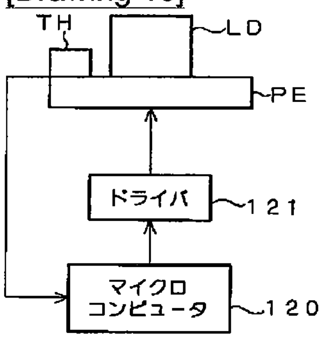
[Drawing 3]



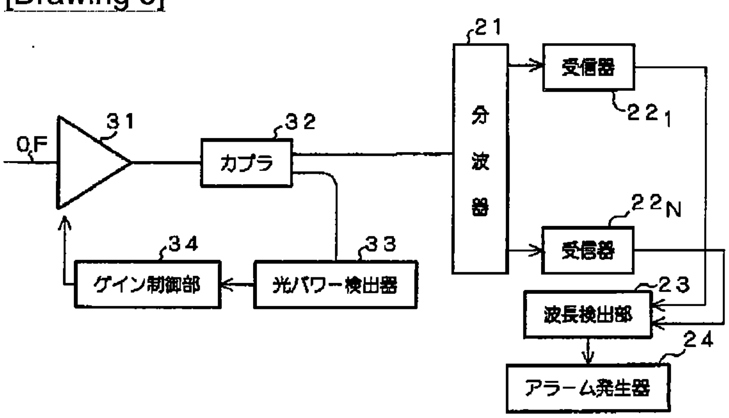
[Drawing 4]



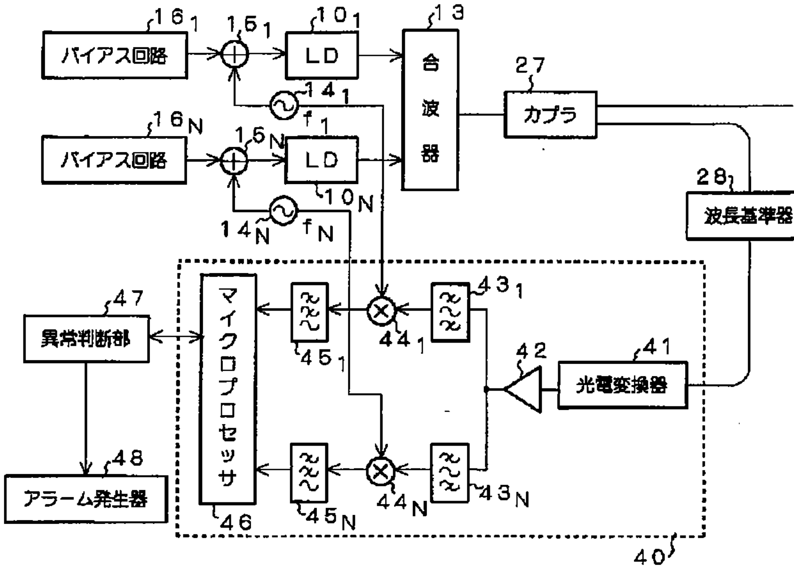
[Drawing 16]



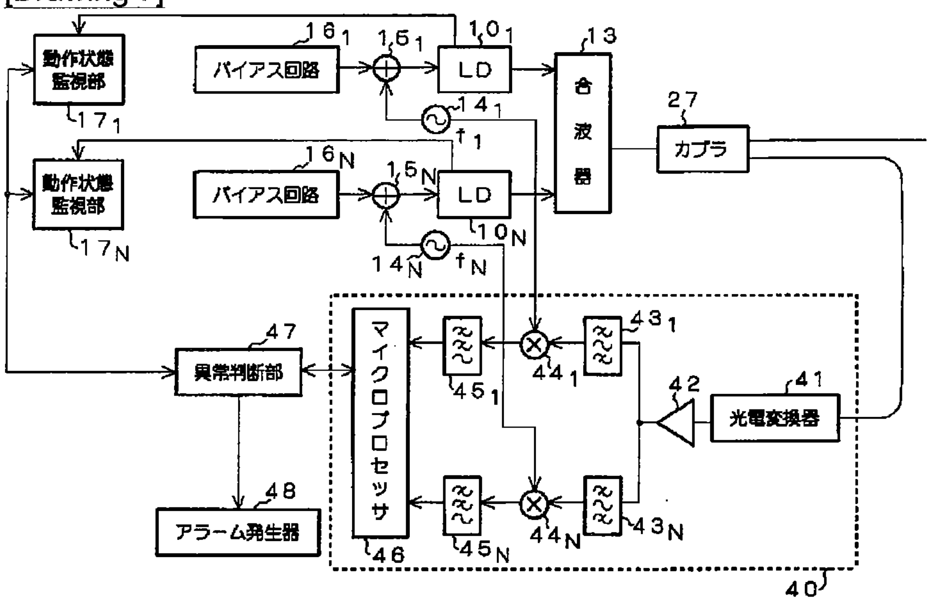
[Drawing 5]



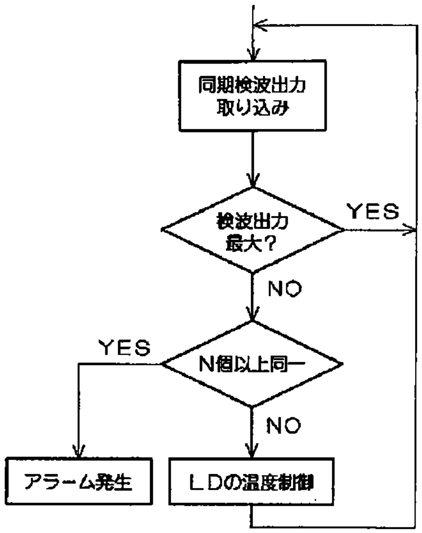
[Drawing 6]



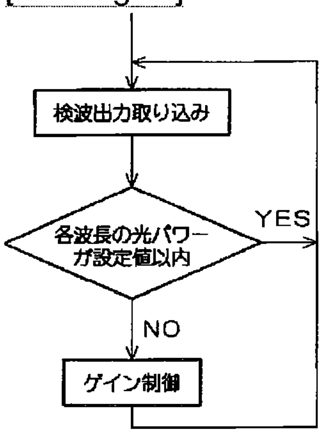
[Drawing 7]



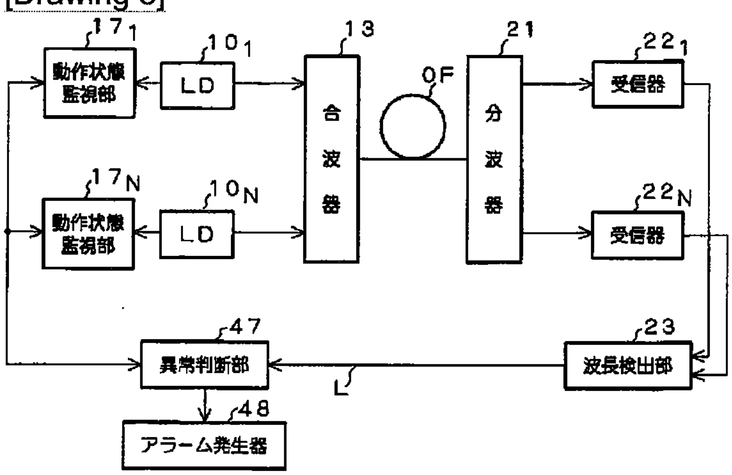
[Drawing 20]



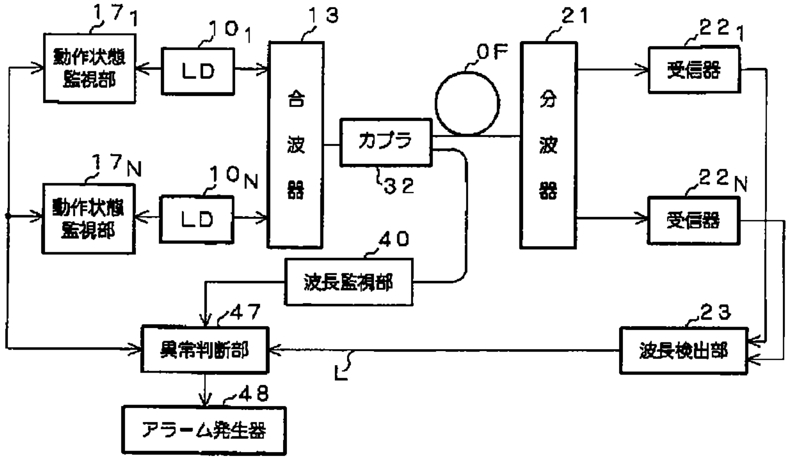
[Drawing 24]



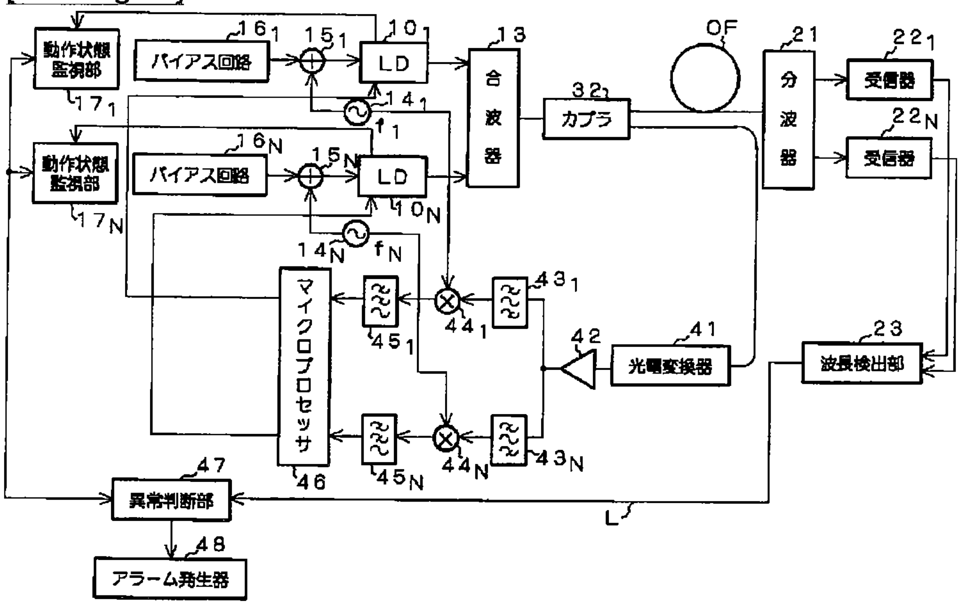
[Drawing 8]



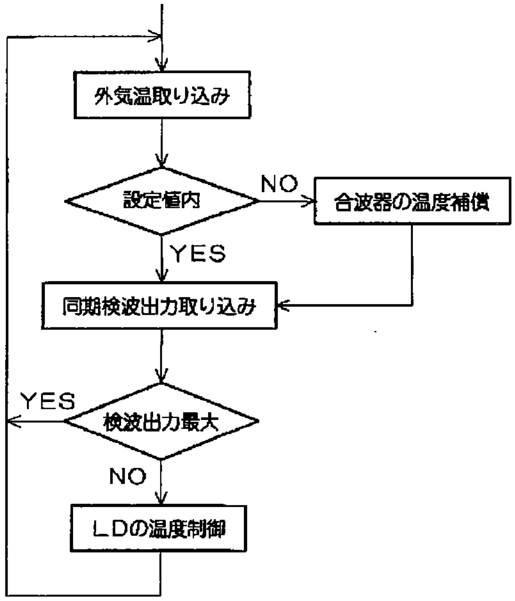
[Drawing 9]



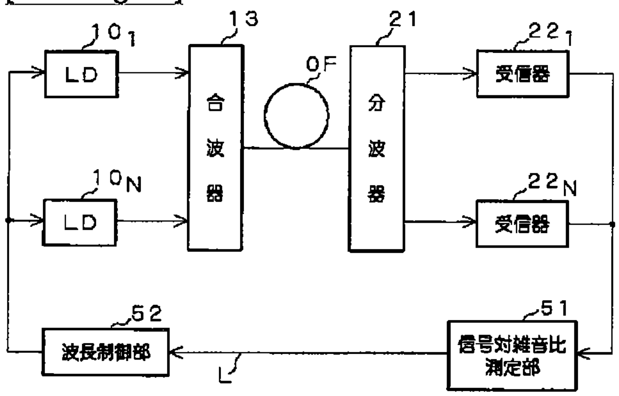
[Drawing 10]



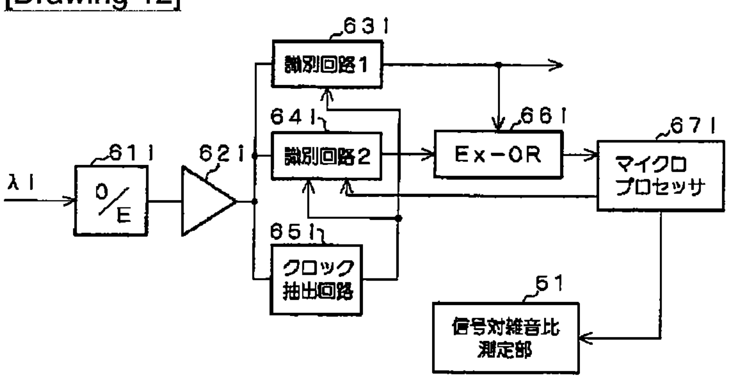
[Drawing 22]



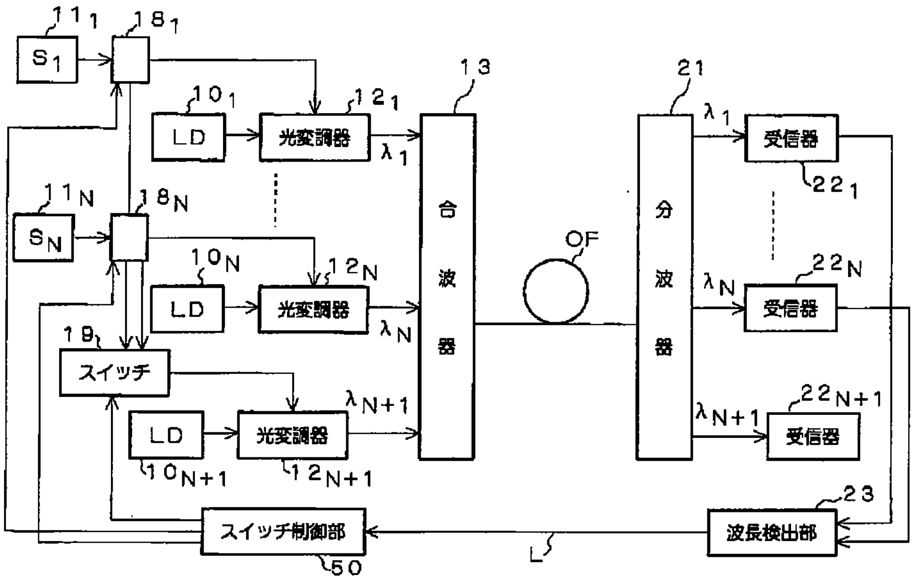
[Drawing 11]



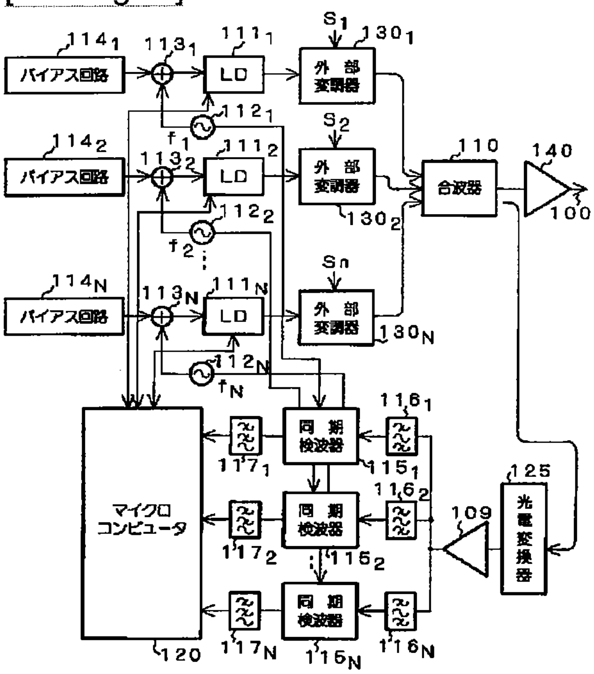
[Drawing 12]



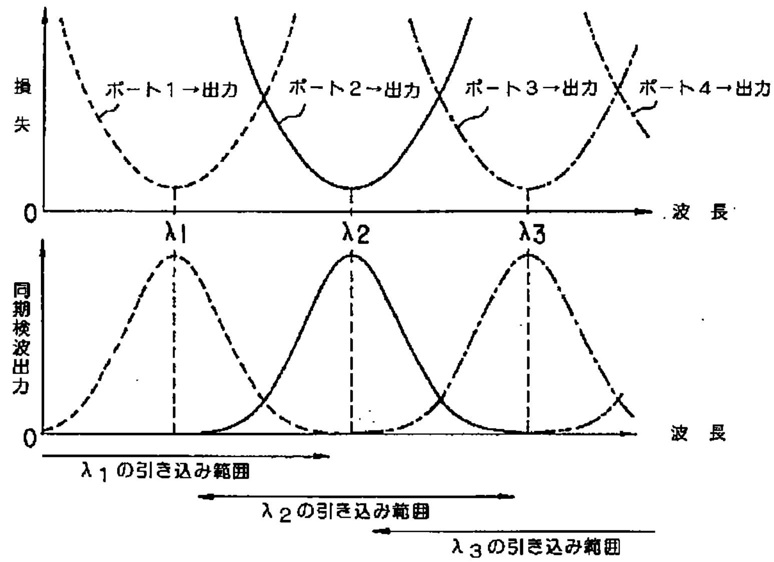
[Drawing 13]



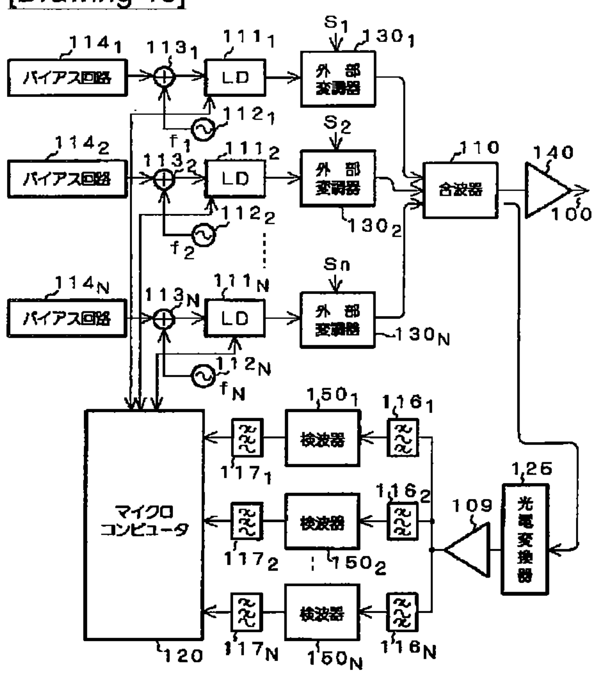
[Drawing 14]



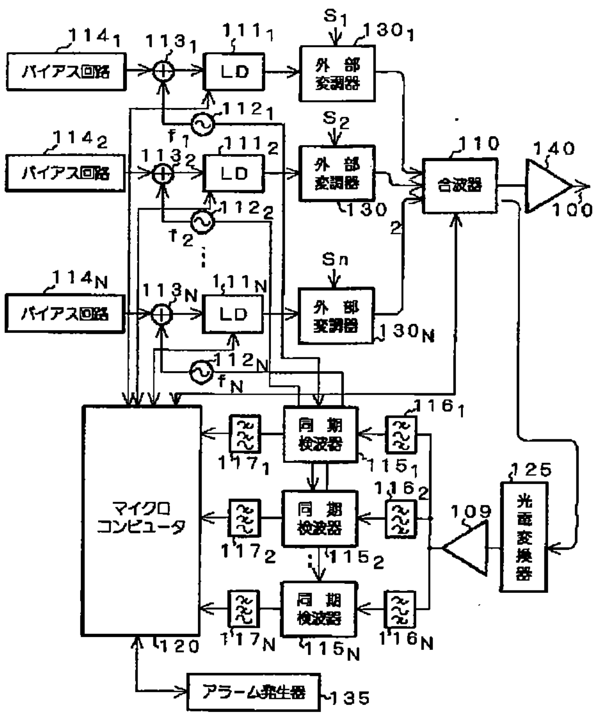
[Drawing 17]



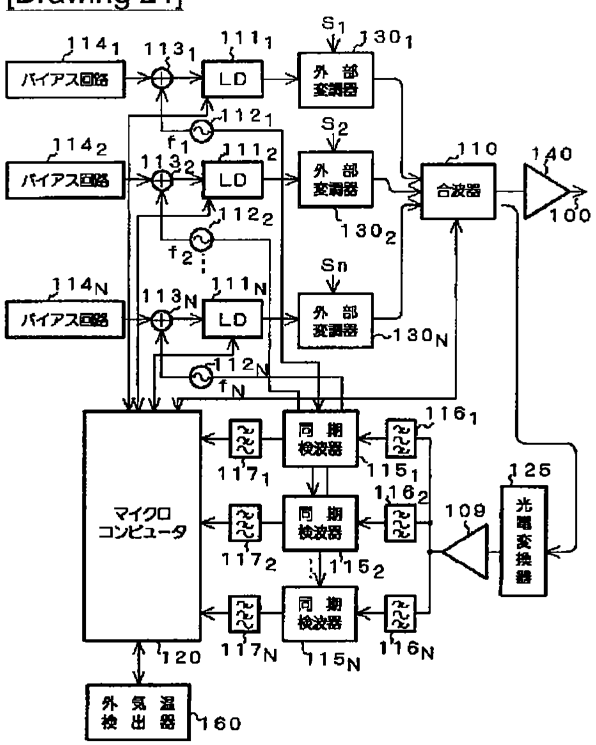
[Drawing 18]



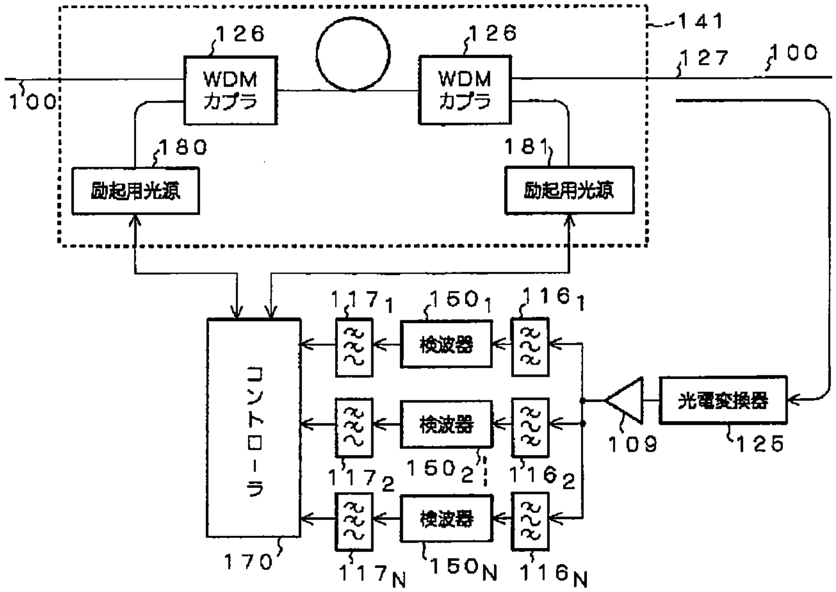
[Drawing 19]



[Drawing 21]



[Drawing 23]



[Translation done.]